

Bank Bailouts, Bank Levy, and Bank Risk-Taking

Von der Wirtschaftswissenschaftlichen Fakultät
der Universität Leipzig
genehmigte

DISSERTATION

zur Erlangung des akademischen Grades
Doctor rerum politicarum
Dr. rer. pol.

vorgelegt

von Diplom-Volkswirt Michael Diemer
geboren am 20. November 1982 in Tübingen
Gutachter: Prof. Dr. Uwe Vollmer
Prof. Dr. Harald Wiese
Tag der Verleihung: 22. Oktober 2014

Preface

The models of this study have been presented in various seminars, workshops and conferences, and I would like to thank the participants for their helpful comments. During the time following these presentations, the papers were reviewed and modified several times. Consequently, the chapters in this dissertation are not identical with the papers presented at these seminars.

Major parts of the paper "Bank Levy and Bank Risk-Taking" and of the paper "Contingent Public Bailout, Contagion and Bank Risk-Taking" were presented 2012 at the 9th Workshop on Money, Banking, and Financial Markets in Düsseldorf (Germany), at the Annual Conference of the Verein für Socialpolitik in Göttingen (Germany) and at the Annual Meeting of the Austrian Economic Association in Vienna (Austria). The paper "Who Should Rescue Subsidiaries of Multinational Banks" was also presented at the Annual Meeting of the Austrian Economic Association and in a Doctoral Seminar at the University of Illinois at Urbana-Champaign. These papers were also presented in the Doctoral Seminars at the University of Leipzig.

The paper "What Makes Banking Crisis Resolution So Difficult? Lessons From Japan and the Nordic Countries" is the only paper written in co-authorship with Uwe Vollmer. Although this paper was developed in close cooperation, some parts of it can be individually allocated. The following subsections were mainly written by Uwe Vollmer: 6.1 "Introduction", 6.2.4 "Crisis resolution obstacles" and 6.4 "Reassessment of current crisis resolution procedures". The Subsections 6.2.2 "Liquidity provisions", 6.2.3 "Bank bailouts", 6.3.1 "Japan", 6.3.2 "Nordic countries" and the "Appendix" were written by the author of the dissertation. Subsections 6.2.1 "Taxonomy", 6.3.3 "Determinants of crisis resolution paths" and 6.5 "Conclusion" are based on the joint efforts of both authors.

Contents

| | |
|---|------------|
| List of Figures | VI |
| List of Tables | VII |
| 1 Introduction | 1 |
| 1.1 Purpose and motivation | 1 |
| 1.2 Methodology | 3 |
| 1.3 Summary and contributions | 5 |
| 1.4 Legal background of bank bailout and bank resolution | 7 |
| 1.4.1 Global level | 7 |
| 1.4.2 European level | 9 |
| 1.4.3 German level | 15 |
| 2 Bank Levy and Bank Risk-Taking | 20 |
| 2.1 Introduction | 20 |
| 2.2 Literature review | 22 |
| 2.3 The model | 24 |
| 2.3.1 Players and action sets | 24 |
| 2.3.2 Sequence of events | 26 |
| 2.3.3 Equilibrium concept | 27 |
| 2.4 The impact of a bank levy on banks' risk-taking in case of secured debt | 28 |
| 2.4.1 Ex ante paid bank levy | 28 |
| 2.4.2 Ex post paid bank levy | 30 |
| 2.5 The impact of a bank levy on banks' risk-taking in case of unsecured debt | 31 |
| 2.5.1 Transparent banks | 31 |
| 2.5.2 Opaque banks | 34 |
| 2.6 Discussion | 36 |
| 2.6.1 Opportunity costs | 37 |
| 2.6.2 Comparison between bank levy and bank profit tax | 39 |
| 2.7 Conclusion | 42 |
| Appendix | 44 |
| 3 Contingent Public Bailout, Contagion and Bank Risk-Taking | 53 |

| | | |
|----------|--|------------|
| 3.1 | Introduction | 53 |
| 3.2 | Literature review | 55 |
| 3.3 | The model | 58 |
| 3.3.1 | Players and action sets | 58 |
| 3.3.2 | Sequence of events | 62 |
| 3.3.3 | Equilibrium concept | 63 |
| 3.4 | Public bank bailouts contingent on the macroeconomic environment . . . | 64 |
| 3.4.1 | Symmetric information on investment decisions | 64 |
| 3.4.2 | Asymmetric information on investment decisions | 68 |
| 3.4.3 | Imperfect information on the state of nature | 69 |
| 3.5 | Public bank bailouts contingent on banks' interconnectedness | 71 |
| 3.6 | Conclusion | 75 |
| | Appendix | 77 |
| 4 | Are Public Bank Bailouts Desirable From a Moral-Hazard Perspective? | 86 |
| 4.1 | Introduction | 86 |
| 4.2 | Literature review | 88 |
| 4.3 | The model | 91 |
| 4.3.1 | Players and action sets | 91 |
| 4.3.2 | Sequence of events | 93 |
| 4.3.3 | Equilibrium concept | 93 |
| 4.4 | Public bank bailouts by a national regulator | 94 |
| 4.4.1 | Symmetric contagion probability | 94 |
| 4.4.2 | Asymmetric contagion probability | 95 |
| 4.5 | International coordination of public bank bailouts | 97 |
| 4.5.1 | High protection possibility | 98 |
| 4.5.2 | Medium protection possibility | 101 |
| 4.6 | Discussion | 104 |
| 4.6.1 | Variation in the number of systemic banks | 104 |
| 4.6.2 | Introduction of a bank levy | 105 |
| 4.7 | Conclusion | 106 |
| | Appendix | 108 |
| 5 | Who Should Rescue Subsidiaries of Multinational Banks? | 115 |
| 5.1 | Introduction | 115 |
| 5.2 | Literature review | 117 |
| 5.3 | The model | 119 |
| 5.3.1 | Players and action sets | 119 |
| 5.3.2 | Sequence of events | 121 |
| 5.3.3 | Equilibrium concept | 121 |

| | | |
|----------|--|------------|
| 5.4 | Optimal allocation of resolution power between national regulators and a multinational regulator | 122 |
| 5.4.1 | Bailout decisions of the regulators | 122 |
| 5.4.2 | Welfare-optimal monitoring effort | 123 |
| 5.4.3 | Monitoring effort of the subsidiary bank | 126 |
| 5.4.4 | Welfare-optimal allocation of bailout responsibility | 127 |
| 5.5 | Implementation of the optimal allocation | 130 |
| 5.5.1 | Without sharing of costs for bailout | 131 |
| 5.5.2 | With sharing of costs for bailout | 132 |
| 5.6 | Allocation of bailout responsibility between a parent bank and a regulator | 135 |
| 5.6.1 | Bailout incentives of the parent bank | 135 |
| 5.6.2 | Cooperation between regulator and parent bank | 136 |
| 5.7 | Conclusion | 137 |
| | Appendix | 138 |
| 6 | What Makes Banking Crisis Resolution So Difficult? Lessons From Japan and the Nordic Countries | 153 |
| 6.1 | Introduction | 153 |
| 6.2 | Financial assistance, policy trade-offs and crisis resolution obstacles | 155 |
| 6.2.1 | Taxonomy | 155 |
| 6.2.2 | Liquidity provisions | 156 |
| 6.2.3 | Bank bailouts | 157 |
| 6.2.4 | Crisis resolution obstacles | 160 |
| 6.3 | Banking crisis resolution in Japan and the Nordic countries | 162 |
| 6.3.1 | Japan | 162 |
| 6.3.2 | Nordic countries | 166 |
| 6.3.3 | Determinants of crisis resolution paths | 171 |
| 6.4 | Reassessment of current crisis resolution procedures | 173 |
| 6.5 | Conclusion | 175 |
| | Appendix | 177 |
| 7 | Conclusion | 181 |
| | Bibliography | 183 |

List of Figures

| | | |
|-----|---|-----|
| 1.1 | Overview of bank recovery, reorganization, restructuring and resolution regulation in Germany | 17 |
| 2.1 | Sequence of events | 27 |
| 2.2 | Equilibria in the opaque case | 37 |
| 2.3 | Equilibria: Bank levy versus profit tax | 42 |
| 3.1 | "Decision tree" of an isolated and prudent bank | 60 |
| 3.2 | Sequence of events | 63 |
| 3.3 | Equilibria under symmetric information | 67 |
| 4.1 | Sequence of events | 94 |
| 4.2 | Conflict of interests in the case of asymmetric contagion probabilities . . . | 97 |
| 4.3 | Payoffs in the case of high protection possibility | 100 |
| 4.4 | Payoffs in the case of medium protection possibility | 102 |
| 4.5 | Equilibria in the regulators' game | 103 |
| 5.1 | Payoffs of the regulators | 121 |
| 5.2 | Sequence of events | 122 |
| 5.3 | Bailout decisions of the regulators if only one regulator is in charge | 124 |
| 5.4 | Game tree of the regulators' game without sharing of bailout costs | 131 |
| 5.5 | Game tree of the regulators' game with sharing of bailout costs | 133 |

List of Tables

| | | |
|-----|---|-----|
| 1.1 | Prevention, early intervention and resolution measures | 15 |
| 6.1 | Forms of public financial assistance to troubled banks | 156 |
| 6.2 | Important crisis resolution measures in Norway, Sweden, Finland and Japan | 177 |

Chapter 1

Introduction

1.1 Purpose and motivation

This thesis consists of five essays. Although each essay is self-contained, they all share a common theme: the relation between regulatory intervention and the risk-taking behaviour of banks. Two major instruments of regulatory intervention are considered: bank levy and bank bailouts. The objective of this thesis is to provide an answer to the following questions: Do bank levies increase the risk-taking of banks in a competitive environment? When do bank bailouts decrease banks' risk-taking? Does the international coordination of bank bailouts affect the relation between bailouts and the risk-taking behaviour of banks? Who should rescue subsidiaries of multinational banks? How could an efficient coordination of bank bailouts be designed and implemented?

The extensive public interventions by central banks and the fiscal authorities as well as the severe outcome of the recent financial crisis have brought these topics back to the political agenda.¹ In order to avoid a collapse of the financial system, liquidity assistance by Central Banks as well as solvency assistance by governments were necessary. The European Central Bank (ECB), the US Federal Reserve (FED) and the Bank of England (BoE) decreased their main refinancing rate by more than 400 basis points within a few months.² In addition, the ECB, for instance, changed its monetary policy framework and applied a fixed-rate tender procedure with full allotment, which replaced the previous variable rate tender with fixed allotted amount. Apart from direct liquidity support to banks, Central Banks, in particular the FED, have also purchased short-term papers and long-term securities to strengthen the interbank market and the long-term securities market. These purchases were intensified when sovereigns began to get distressed. Then, the CBs expanded their programme to the purchase of government bonds.

¹For a description of the recent crisis and policy reactions, see, for instance, Bordo (2008); Petrovic & Tutsch (2009) and Acharya & Richardson (2009).

²On this point, and the examples that follow, see <http://www.federalreserve.gov/newsevents/speech/bernanke20090113a.htm> (12 January 2014), <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb110301.pdf> (12 January 2014), and European Central Bank (2010).

Apart from liquidity assistance to the financial markets and institutions, solvency assistance, for instance, through guarantees on bank liabilities and assets was provided in many developed countries such as Germany, France, the United Kingdom and the United States and in some developing countries (Laeven & Valencia (2012)). These interventions were accompanied by direct recapitalization or even nationalization of important financial institutions in Germany (e.g. Commerzbank, Hypo Real Estate), France (e.g. BNP), the Netherlands (e.g. Fortis, ING), Switzerland (e.g. UBS), the United Kingdom (e.g. RBS, Northern Rock) and the United States (e.g. Fannie Mae and Freddie Mac).

Despite the long list of crisis experiences in the second half of the 20th century, it could not be avoided that many countries suffered from large fiscal costs and output losses (Caprio & Klingebiel (2002); Laeven & Valencia (2008); Reinhart & Rogoff (2008)).³ Laeven & Valencia (2012) determine fiscal costs of 1.8% of GDP in Germany, 1% of GDP in France, 8.8% of GDP in United Kingdom, 4.5% of GDP in the United States and 27.3% of GDP in Greece. Output losses amounted to 11% of GDP in Germany, 23% of GDP in France, 25% of GDP in the United Kingdom, 31% of GDP in the United States and 43% of GDP in Greece.⁴

To avoid a recurrence of such a global financial turmoil, the Group of Twenty (G-20) agreed on guiding principles for regulatory reforms, such as the enhancement of sound regulation and the reinforcement of international cooperation.⁵ To ensure the enhancement of sound regulation, "financial institutions should have clear internal incentives to promote stability". The reform of international cooperation entails the collaboration of national supervisors through the establishment of supervisory colleges for all major cross-border financial institutions. These colleges should strengthen the surveillance of the activities of financial institutions and assess the risks as well as regulate the cross-border crisis management. Major reforms initiated on the summit in Washington D.C. have already been transposed in international agreements and supranational and/or national law. These reforms also stipulate that financial institutions should bear the losses in a financial crisis, as required by the G-20.

In the European Union, the establishment of a Banking Union has been considered as an adequate way to avoid the recurrence of such a crisis. The Banking Union aims to harmonize banking regulation in the European Union. Recently, the Members of the European Union agreed on the Single Resolution Mechanism (SRM), one of the key components of the Banking Union. The SRM focuses on a bail-in tool, where shareholders and creditors bear the costs

³Caprio & Klingebiel (2002) find 113 systemic banking crises in 93 countries, and they document 50 borderline and smaller banking crises in 44 countries between the late 1970s and 2002. They consider a crisis as systemic if much, or all, bank capital is exhausted. Laeven & Valencia (2008) identify even 124 systemic banking crises between 1970 and 2007. They consider a crisis as systemic if "a country's corporate and financial sectors experience a large number of defaults and financial institutions and corporations face great difficulties repaying contracts on time".

⁴Laeven & Valencia (2012) measure output losses as the cumulative sum of the differences between actual and trend real GDP expressed as a percentage of trend real GDP. They define fiscal costs as the component of gross fiscal outlays related to the restructuring of the financial sector. Fiscal costs associated with bank recapitalizations are included, but asset purchases and direct liquidity assistance from the treasury are excluded.

⁵On this point and the following remarks, see <http://www.oecd.org/g20/meetings/washington-dc/declarationofthesummitonfinancialmarketsandtheworldconomy.htm> (23 January 2014).

of a bank failure, as the main resolution tool. Public intervention costs in a crisis have to be paid by a fund which is financed by the banks themselves through a bank levy. Cooperation between resolution authorities shall be established in the crisis prevention period in order to facilitate public intervention in a crisis scenario.

The following chapters analyse the relation between two key components of the SRM - the bank levy and the cooperation between resolution authorities -, and a main objective declared by the G-20: banks' incentives to promote stability. Although the bail-in tool (conversion of debt into equity) is a key component of the SRM, bailouts, or at least the assistance to struggling banks, should not be excluded. The Bank Recovery and Resolution Directive (BRRD)⁶ does not explicitly exclude such support: "In order to avoid moral hazard, any failing institution should be able to exit the market, irrespective of its size and interconnectedness, without causing systemic disruption. A failing institution should in principle be liquidated under normal insolvency proceedings. However, liquidation under normal insolvency proceedings might jeopardise financial stability, interrupt the provision of critical functions, and affect the protection of depositors. In such a case it is highly likely that there would be a public interest in placing the institution under resolution and applying resolution tools rather than resorting to normal insolvency proceedings. The objectives of resolution should therefore be to ensure the continuity of critical functions, to avoid adverse effects on financial stability, to protect public funds by minimising reliance on extraordinary public financial support to failing institutions and to protect covered depositors, investors, client funds and client assets (BRRD)."

As the ordinary resolution tools, such as the bail-in tool, have not yet been tested in a real crisis, and due to the fact that it will take time to prepare global institutions for such a tool in a crisis, it may be useful to have an adequately designed "tool of last resort", such as a bailout, in order to avoid the disruption of critical functions. Therefore, the essays also deal with the impacts of bank bailouts on the risk-taking behaviour of banks and ask which bailout policy could avoid moral hazard and enforce sound behaviour of banks.

1.2 Methodology

Although the essays are self-contained, each chapter shares with other chapters common methodology aspects. This does not mean that the basic cornerstones presented in the following are the same in all essays. Peculiarities will be presented in each chapter separately. Chapter 6 differs from the other chapters in as much as it does not provide a model, but it provides a review of the literature on the relation between regulatory intervention and banks' risk-taking. This chapter studies regulatory interventions in previous episodes of crises by using a case-study approach.

⁶Directive 2014/59/EU of the European Parliament and of the Council of 15 May 2014 establishing a framework for the recovery and resolution of credit institutions and investment firms and amending Council Directive 82/891/EEC, and Directives 2001/24/EC, 2002/47/EC, 2004/25/EC, 2005/56/EC, 2007/36/EC, 2011/35/EU, 2012/30/EU and 2013/36/EU, and Regulations (EU) No 1093/2010 and (EU) No 648/2012, of the European Parliament and of the Council, OJ L 173, 12 June 2014, p. 190.

Methodologically, the aim of the thesis is to study how bank regulation affects the risk-taking behaviour of banks from a theoretical point of view. Therefore, the focus is on one of the key banking functions: managing risks. The banks' risk management can be analysed in various ways as there are diverse risks in a bank. A fundamental distinction is between liquidity risk and solvency risk. Liquidity risk occurs when a bank faces unexpected cash payments, whereas solvency or credit risk occurs when a borrower is unable to repay a debt or, generally, when the project of the bank fails. While the first type of risk concentrates on the liability side of a balance sheet, the solvency risk concentrates on the asset side of a balance sheet (Freixas & Rochet (2008)). The focus of the following essays is on solvency risk.⁷

Solvency risk or credit risk can be modeled in several ways. A prominent way of modeling credit risk decisions in banking is the portfolio approach (Hart & Jaffee (1974); Kim & Santomero (1988)). This approach deals with banks choosing their optimal investment, depending on the return and risk of the portfolio, as well as on their risk preferences. In general, we follow this basic approach, but assume that banks are risk-neutral (Cordella & Yeyati (2003)). Therefore, the portfolio choice of the banks is based on expected payoffs of the portfolios. Due to limited liability of banks, the portfolio with the highest expected payoff is not necessarily the bank's optimal choice. The key determining factor of the bank's behaviour throughout the essays is the choice between high payoffs and safe investments. This trade-off can also be obtained by a setup in which banks monitor their creditors, where this monitoring is costly (Holmstrom & Tirole (1997)). Both setups will be applied in this thesis, depending on which approach is more convenient.

We not only analyse the risk-taking of a bank in isolation, but we also consider competition among banks. Therefore, we use the industrial organization approach and apply it to the banking sector (Freixas & Rochet (2008)). The focus is on the monopolistic competition setup à la Hotelling (1929) and Salop (1979), where firms (banks) compete on the market for customers, e.g. depositors. In the Hotelling model, two firms, located on a street line, compete in the market for customers, whereas Salop models competition among more than two firms. As long as the number of firms is "irrelevant", we direct our attention on the setup à la Hotelling.

In this thesis, the impact of bank regulation on the risk-taking behaviour of banks is always studied in a setup of simple non-cooperative games, where the player set consists of the banks, shareholders and creditors (depositors) and the regulator. We consider subgame perfect equilibria and solve the games by backward induction if the games are in extensive form. In one section, we need the perfect Bayesian equilibrium concept. If the games are static, we use the Nash equilibrium as the equilibrium concept. Except in base scenarios, the information among the players is asymmetric. Hence, the players cannot observe each others' actions. As a consequence, a regulator, for instance, cannot observe a bank's risk decisions and, therefore, cannot condition his bailout policy on the bank's risk behaviour. However,

⁷For further details on the relationship between regulation and liquidity risk, we refer the reader to Chapter 6.

even if the regulator was able to observe a bank's risk-taking, he may not be able to condition his bailout policy on the bank's behaviour. This is only possible if the regulator and the bank can sign a contract which forces the regulator to pursue a pre-defined bailout policy. Such a contract is called "complete".

The literature differentiates between "complete" and "incomplete" contracts. For example, complete-contract models deal with situations where a contingent contract on states of nature can be signed, as they are observable and verifiable by a third party, e.g. a court (Freixas & Rochet (2008)). Consider, for instance, a shock that may hit a bank and force it into insolvency. This shock might be observable and verifiable by a court which allows the regulator and the banks to sign a contract promising a certain bailout probability depending on the state of nature or the systemic relevance of the bank. This approach is used in Chapters 3 and 4. Incomplete-contract models deal with situations where a contingent contract, if written, would have no legal value, since no court would be able to determine the contingent obligations of either party. Consider, for instance, a shock that may hit a bank and run it into insolvency. Although both regulators and banks can observe the shock, they cannot sign a contract which allocates a bailout probability to each type of shock, since it cannot be verified by a third party. Consequently, an ex ante announcement is not credible (Repullo (2000); Kahn & Santos (2005)). This approach is used in Chapter 5. In Chapter 2, bailouts are not taken into consideration and, therefore, the differentiation between complete and incomplete contracts is not necessary. It may be worthwhile to mention that the distinction between complete and incomplete contracts could or has to be made in the case of each contract between any parties. However, contracts between depositors and banks are considered as complete contracts throughout this dissertation and, therefore, we only distinguish between complete and incomplete contracts explicitly when referring to the linkage between the regulator and the banks.

1.3 Summary and contributions

This dissertation consists of seven chapters. Detailed contributions to the literature are presented in the literature review at the beginning of each chapter. In order to avoid repetitions, we concentrate in this section on some key papers from which the models presented below borrow specific elements.

The following part of Chapter 1 (Introduction) describes the regulatory developments on the global, European and German level. We focus on the euro area and on Germany as this country plays a major role in the European banking sector. Besides, as this regulation is led by European authorities, the cornerstones of bank regulation are the same in all countries which belong to the European (Monetary) Union and, as such, Germany is a representative case for all European countries.

Chapter 2 analyses the impact of a bank levy on the risk-taking behaviour of banks in a competitive environment. The setup is similar to Repullo (2004), though he focuses on the

relation between capital requirements and risk-taking behaviour of banks competing on the deposit market. As a main result, we show that a bank levy may decrease banks' risk-taking behaviour depending on whether banks' are financed through secured or unsecured debt and depending on whether banks are transparent or opaque. Although the effects of fees on banks have already been discussed (Shin (2010), Perotti & Suarez (2009) and Gorton & Huang (2004)), the relation between a bank levy and banks' risk-taking in a competitive environment has not been studied extensively.

Chapter 3 examines how *ex ante* announced bank guarantees influence the risk-taking behaviour of banks in a competitive environment. In general, we proceed with the setup of Repullo (2004) and combine it with one ingredient of the setup used in Cordella & Yeyati (2003), who analyse the impact of bank bailouts on a bank's risk-taking behaviour where no competition is involved. We show that competition matters with regard to the impact of bank bailouts on banks' risk-taking. The success of the bailout policy in avoiding moral hazard depends on the regulator's ability to condition his bailout policy in accordance with the macroeconomic environment, which has an impact on the banks' probability of success, or on his ability to condition the bailout policy on the banks' systemic relevance. This essay contributes to the recent literature by challenging some assumptions used in the paper of Cordella and Yeyati, and by investigating the combination of bank competition, charter value and systemic relevance of banks.

Chapter 4 takes both a bank guarantee and a bank levy into account. It borrows from the setup in Dell'Ariccia & Ratnovski (2011), where the failure of banks can spill over to other banks which do not compete with each other. The main finding is that bailouts can decrease banks' risk-taking behaviour if the authorities only rescue struggling banks which are systemic. This contrasts with the finding of the previous chapter, where bank bailouts reduce risk-taking if banks are not too systemic. Furthermore, by extending the basic setup of Dell'Ariccia and Ratnovski, the essay examines under which conditions a coordination of bank bailouts is desirable in a case where banks are located in their home country, but their failure affects the survival of banks in neighbouring countries. The main result is that coordination of bailouts through a multinational regulator can improve welfare. Finally, a bank levy, which depends on the systemic relevance of banks, has an impact on the efficient bailout policy. This essay provides a simple contagion setup, allowing for several extensions in order to analyse the impact of coordination upon authorities on the risk-taking behaviour of banks.

Chapter 5 analyses the incentives of a multinational bank which is located in a host country, but monitored by its home country. The main result is that the desirability of internationally coordinated bailouts depends on the dimension of the crisis. If the crisis is severe, it may be more efficient to delegate bank bailouts to a multinational regulator. However, such a delegation is not always feasible. Therefore, a pre-defined burden sharing of bank bailouts is necessary in order to achieve an efficient resolution of banks in distress. This analysis is in line with Mikkonen (2006), who, however, does not ask how an efficient bailout policy can be implemented. The essay also contributes to Repullo (2000), who asks whether a central

bank or a deposit insurance should rescue a failing bank, and to Kahn & Santos (2005), who examine whether the lender of last resort and deposit insurance functions should be allocated to one authority. In addition to Niepmann & Schmidt-Eisenlohr (2013) and Goodhart & Schoenmaker (2009), we justify the optimal coordination and financing arrangement from a moral hazard (risk-taking) point of view.

Chapter 6 complements the previous chapters by focusing on crisis resolution barriers. It follows a case-study approach and detects obstacles which deter regulators from pursuing an efficient bailout policy (Yin (2003)). As the impacts of the recent financial crisis are still on-going, we draw lessons from Japan and the Nordic countries in the 1990s. This essay is in line with Calomiris, Klingebiel & Laeven (2004), who draw lessons from several crises in Japan, Mexico and Sweden, for example. The approach presented in this thesis differs in the country sample and in the focus. In contrast to Calomiris et al. (2004), we link the case-study to the recent literature on the relation between bank bailouts and banks' risk-taking behaviour as well as direct fiscal costs of bailouts.

Chapter 7 concludes the dissertation. It provides some policy implications and lists some open questions for further research. A summary of the chapters will be provided in each chapter separately and, therefore, will not be repeated in the conclusion.

The literature which deals with similar topics is described in each chapter separately. Since the chapters are similar to the papers which were already presented on several conferences, repetitions are inevitable, especially with regard to the cited literature and the framework. Nevertheless, we tried to avoid as many repetitions as possible and mainly used the same symbols in each chapter in order to facilitate reading.

1.4 Legal background of bank bailout and bank resolution

The objective of this section is threefold. Firstly, it aims to summarize the recent developments and current situation of cooperation among national supervisory authorities. Due to the fact that this is the key topic in Chapters 4 and 5, the current legal framework for cooperation is described in more detail. Secondly, it provides some insights into the regulation of the bank levy in Germany because this topic becomes important in Chapters 2 and 4. Thirdly, this section describes the instruments available in a situation where individuals or a group of institutions are in trouble. Moreover, it specifies the requirements for recovery and resolution processes.

1.4.1 Global level

In the aftermath of the financial crisis of 2007-2008, the stabilization of financial markets became a major goal, and financial sector reforms were an important instrument to achieve

it. The financial crisis illustrated the importance of cross-border crisis management because the tools and techniques for handling cross-border bank crisis resolution did not evolve at the same pace as the scope and complexity of international financial transactions expanding in the pre-crisis period. The crisis management revealed gaps in intervention techniques and the absence of an appropriate set of resolution tools in many countries. Actions taken to resolve cross-border institutions during the crisis were rather ad hoc and severely limited by time constraints. In order to fill these gaps, the Basel Committee's Cross-border Bank Resolution Group developed a set of recommendations.⁸ At the summit in Washington D.C. in 2008, the G-20 announced guidelines for the development of new rules which were to ensure cooperation among national regulators, support market discipline, avoid adverse impacts on other countries, and promote competition and innovation.

The Basel Committee's recommendations are intended to strengthen national resolution powers and their cross-border implementation. They also provide guidance for bank-specific contingency planning, as banks, as well as key home authorities and host authorities, must develop practical and credible plans to promote resiliency in periods of severe financial distress and to facilitate a rapid resolution, should that be necessary. The recommendations also aim to reduce contagion by advocating the use of risk mitigation mechanisms, such as the use of regulated central counterparties.⁹

Due to the fact that large financial institutions operate in home jurisdictions and in host jurisdictions, an international coordination of national bank resolution measures is essential (Basel Committee on Banking Supervision (2010)). Information sharing among national authorities and the recognition of foreign crisis management and resolutions are seen as major steps in achieving such coordination. Cooperation between national authorities should be ensured by the establishment of supervisory colleges for major cross-border financial institutions. Guidelines for the colleges and for sharing information are provided by the re-established Financial Stability Board (FSB).¹⁰ These colleges already exist for major banks in Europe and convene on a regular basis. Their task is to coordinate bank regulation in normal times, i.e. intervene at early stages, but also to prepare resolution strategies for emergencies.

Agreements between host and home authorities should define the role and responsibility of home and host country regulators for managing the resolution of failed systemic institutions. These plans might even force the multinational banks to change their legal and operational structure and business practice in order to facilitate their resolution and recovery in times of distress. The procedures should, for instance, facilitate the transfer of ownership of systemically

⁸The Basel Committee is the primary global standard-setter for the prudential regulation of banks and it provides a forum for cooperation on banking supervisory matters. For an overview of the members of the Committee, see <http://www.bis.org/bcbs/membership.htm> (3 February 2014).

⁹<http://www.bis.org/publ/bcbs169.htm> (15 March 2014).

¹⁰The FSB was established to coordinate the work of national financial authorities and international standard-setting bodies and to develop the implementation of effective regulatory and supervisory policies. The initial mandate was given to the Financial Stability Forum by the Finance Ministers and Central Bank Governors of the Group of Seven in 1999. A broadened mandate was given by the Group of Twenty in London in 2009. See https://www.financialstabilityboard.org/publications/r_120809.pdf (3 February 2014).

relevant parts of failed institutions to another private firm or to a bridge financial institution (Basel Committee on Banking Supervision (2010)).

Early interventions include the requirement to facilitate financial institutions' group structures in order to guarantee the orderly resolution of such banks. Individual units should, for instance, be separable, intra-group blanket guarantees should be minimised and the separability of global payment and settlement services should be ensured (Basel Committee on Banking Supervision (2010); Financial Stability Board (2010)). Apart from ensuring the resolution of individual financial entities, the authorities in each country should enable the resolution of conglomerates by providing the power for resolution authorities to intervene into these institutions. The FSB also provides guidelines for the handling of systemic financial institutions which cannot be liquidated (Financial Stability Board (2010)). Accordingly, these institutions should be subject to higher loss-absorbency capacity than non-systemic institutions. This would include capital and liquidity surcharges as well as tighter exposure restrictions. Furthermore, national authorities should intensify the supervision of these institutions and develop adequate resolution schemes which do not pass the burden to tax payers. Therefore, authorities should strengthen on-site supervision and require stress tests measuring the resilience of credit institutions to shocks and their ability to absorb liquidity and solvency shocks.

1.4.2 European level

On the European level, the recent financial crisis and the aims proclaimed by the G-20 changed the regulation and supervisory framework tremendously. By the implementation of the banking union, bank supervision has been partially transferred from national regulators to a multinational authority. The cornerstones of the new supervisory framework in the European Monetary Union are the Single Supervisory Mechanism (SSM), the Single Resolution Mechanism (SRM), a European bank deposit insurance scheme and the harmonization of the rulebook. The SSM has the task of harmonizing bank supervision in the European Monetary Union by transferring part of the regulatory power to the European Central Bank.¹¹ It is complemented by the Single Resolution Mechanism (SRM) which aims to achieve a harmonization of banking resolution and the funding for the resolution of banks. The level of deposit protection has been increased to 100.000 € in the EU. However, a pan-EU deposit guarantee scheme is currently not under discussion. Therefore, this topic will not be treated within this context. Major parts of the single legal framework are the new capital regulations, Capital Requirement Regulation (CRR)¹², which came into force in January of 2014, and the Capital Requirements Directive

¹¹The SSM is called a mechanism because the European Treaty framework did not provide the possibility of creating a centralized European institution with the power of bank supervision. However, the Treaty allows the transfer of specific tasks to the ECB.

¹²Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012, OJ L 176, 27 June 2013, p. 1.

IV (CRD IV)¹³, which has to be transposed into national law, as well as the Bank Recovery and Resolution Directive (BRRD), which has been adopted in April 2014 by the European Parliament and in May 2014 by the European Council. Member States must comply with this Directive at the beginning of 2015.¹⁴ The European Banking Authority (EBA) will continue with the development of a single rulebook for banks and a single handbook for supervisors by designing technical standards.

Single Supervisory Mechanism

On 12 September 2012, the Commission adopted two proposals for the establishment of a Single Supervisory Mechanism (SSM) for banks led by the European Central Bank (ECB). The Euro area summit in summer 2012 called on the Commission to present proposals for the setting up of a Single Supervisory Mechanism as a precondition for a possible direct recapitalisation of banks by the ESM (European Stability Mechanism). This was followed by national parliamentary procedures which have been completed in the meantime. The SSM has come into force in the autumn of 2013. The supervisory powers of the ECB will be fully effective and operational one year after coming into force. In order to separate ECB's monetary tasks and supervisory tasks, the governance structure of the ECB will consist of a separate Supervisory Board supported by a steering committee, the ECB Governing Council, and a mediation panel for solving disagreements that may arise between national competent authorities and the Governing Council.¹⁵ Before the ECB starts with the supervision, the balance sheets of the large banks are assessed in the spring of 2014, and the institutes will have to undergo a stress test.

The SSM applies to all the euro-area Member States, but non-euro area Member States can decide to join the SSM by establishing a cooperation with the ECB. The Regulation confers key supervisory tasks and powers over all the credit institutions established within the euro area to the ECB, i.e. investment firms are not included.¹⁶ The ECB carries out its tasks in close cooperation with national authorities through the establishment of joint supervisory teams. Hence, the ECB does not have omnipotent tasks and powers. It shall ensure the coherent and consistent application of the single rulebook in the euro area and contribute to the safety and soundness of credit institutions. The ECB will directly supervise significant banks which are measured in an economically relevant manner, for instance, by their size, and those belonging to the three most significant credit institutions in each Member State. In addition, institutions, receiving direct assistance from the ESM, will also be supervised by the ECB. The national authorities will, in general, remain the competent authority for the daily supervision of less

¹³Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC, OJ L 176, 27 June 2013, p. 338.

¹⁴Some exceptions apply for certain parts of this Directive. See article 130 BRRD.

¹⁵http://europa.eu/rapid/press-release_MEMO-13-899_en.htm?locale=en (15 March 2014).

¹⁶This may lead to conflicts of interests between bank supervision and monetary policy.

significant credit institutions. The ECB will send instructions to national supervisors, and national supervisors will have the duty to notify the ECB of supervisory decisions of material consequence. For cross-border banks which are active both within and outside Member States participating in the SSM, current home/host supervisor coordination procedures will continue to exist as they do today. Despite the fact that daily supervision of less significant institutions remains the responsibility of national authorities, the ECB has exclusive competences with respect to all credit institutions of the Member States, such as the licensing and withdrawal of license. The ECB has exclusive competences for certain functions that are core banking supervisory functions and enumerated in the SSM Regulation, such as to carry out supervisory reviews, including stress tests.¹⁷

Single Resolution Mechanism

The European Parliament and the Council have adopted the Single Resolution Mechanism (SRM) for the Banking Union in April and May 2014, respectively. The SRM Regulation builds on the rulebook on bank resolution set out in the Bank Recovery and Resolution Directive (BRRD). It covers all countries participating in the SSM, i.e. the Member States in the EMU and those non-eurozone countries that decide to join the SSM via cooperation agreements. A Single Resolution Board will prepare resolution plans and resolve all banks directly supervised by the ECB and cross-border banks. National resolution authorities will be responsible for banks which only operate nationally and are not subject to full ECB direct supervision, provided that this will not involve any use of the single fund. The SRM will be fully operational from 1 January 2016.

The agreement includes arrangements for the transfer of national contributions to the fund with an 8-year transitional phase. The fund will be administered by the Single Resolution Board. It will endorse the bail-in rules established in the BRRD as applicable to the use of the single fund. The single resolution fund will be financed by national bank levies and initially consist of national compartments that will be gradually merged over the transitional phase. While during the first years the cost of resolving banks (after bail-in) will mainly come from the compartments of the member states where the banks are located, the share will gradually decrease as the contribution from other countries' compartments increases. During the initial build-up phase of the fund, bridge financing will be available from national sources, backed by bank levies, or from the European Stability Mechanism, in accordance with agreed procedures. Lending between national compartments will also be possible.

Upon notification by the ECB that a bank is failing or likely to fail, or on its own initiative, the board will adopt a resolution scheme placing the bank into resolution. It will determine the application of resolution tools and the use of the single resolution fund. The board will consist of an executive director and the representatives of the national resolution authorities

¹⁷http://europa.eu/rapid/press-release_MEMO-13-899_en.htm?locale=en (15 March 2014). The new framework of the SSM raises questions on several topics such as the division of tasks between national authorities and the ECB.

of all the participating countries. It will be responsible for the planning and resolution of cross-border banks and those directly supervised by the ECB. National resolution authorities will be responsible for executing bank resolution plans under the control of the single resolution board.¹⁸

Recovery and Resolution

On 6 June 2012, the Commission adopted a legislative proposal for the Bank Recovery and Resolution Directive (BRRD). The proposed framework sets out the necessary steps and powers to ensure that bank failures across the EU are managed in a way which avoids financial instability and minimises costs for taxpayers. An agreement was reached on 12 December 2013 between the European Parliament, EU Member States and the Commission on the directive. In April and May 2014, respectively, the BRRD has been approved by the European Parliament and the European Council. Now it has to be transposed into national law.¹⁹

The directive is aimed at providing national authorities with common powers and instruments to avoid bank crises and to resolve any financial institution in an orderly manner in the event of failure, while, at the same time, preserving essential bank operations and minimising taxpayers' exposure to losses. The directive establishes a range of instruments to tackle potential bank crises at three stages: preparatory and preventative, early intervention, and resolution (Table 1.1).²⁰ To ensure that institutions always have a sufficient loss-absorbing capacity, the national authorities should set minimum requirements for own funds and eligible liabilities for each institution. This capacity depends on the size, risk and business model of the institution.²¹

As a preventive measure, recovery and resolution plans ("living wills") have to be designed. Member States shall ensure that the institutes develop a recovery plan which entails, for instance, a communication and disclosure plan outlining how the firm intends to manage any potentially negative market reactions, a range of capital and liquidity actions to restore the institution's financial position in the recovery period, a detailed description of any material impediment to the effective and timely execution of the plan, identification of critical functions which the institution fulfills, arrangements and measures to conserve or restore the institution's capital base and measures to reduce risk and leverage. Moreover, the plans shall include a range of scenarios of severe financial stress, including system-wide events, legal-entity-specific stress and group-wide stress. Recovery plans shall not assume any access to extraordinary

¹⁸http://europa.eu/rapid/press-release_STATEMENT-14-77_en.htm?locale=en (4 April 2014).

¹⁹http://ec.europa.eu/internal_market/bank/crisis_management/index_en.htm (15 March 2014)

http://europa.eu/rapid/press-release_STATEMENT-14-119_en.htm (20 May 2014)

http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ecofin/142492.pdf (20 May 2014).

²⁰Table 1.1 is based on DG Internal Market and Services (2011) and the BRRD. See http://ec.europa.eu/internal_market/consultations/docs/2011/crisis_management/consultation_paper_en.pdf (20. Mai 2013).

²¹http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ecofin/142492.pdf (20 May 2014).

public financial support, but shall include an analysis of how and when an institution may apply for the use of central bank facilities in stress scenarios and identify those assets which would be expected to qualify as collateral (article 5 BRRD).²² The competent authority can require revised plans and even direct the institution to make specific changes to its business and risk profile if there are material deficiencies or potential impediments to its implementation (article 6 BRRD).

The resolution authority, in cooperation with the resolution authorities of the jurisdictions in which any significant branches and subsidiaries are located, shall draw up a resolution plan for each institution (article 10 BRRD). The resolution plan shall prepare the resolution authority for emergencies. It shall take into consideration a range of ideosyncratic and systemic scenarios and, in general, not assume any extraordinary public financial support. It shall include, among others, a demonstration of how critical functions and core business lines could be separated from other functions so as to ensure continuity upon the failure of the institution.

Resolution authorities shall assess the extent to which an institution is resolvable without extraordinary public financial support apart from the use of the financing arrangements (article 15 BRRD). An institution shall be deemed resolvable if it is feasible and credible for the resolution authority to either liquidate it under normal insolvency proceedings or to resolve it by applying the different resolution tools and powers without giving rise to significant adverse consequences for financial systems. Member States shall ensure that resolution authorities have the power, for instance, to require the institution to draw up service agreements in order to cover the provision of critical functions, to require the institution to limit its exposures and to require the institution to divest specific assets (article 17 BRRD).

Moreover, Member States shall ensure that a parent institution and its subsidiaries covered by the consolidated supervision may agree on the provision of financial support for any other party that meets the conditions for early intervention (article 19 BRRD). Financial support may only be provided by a group entity in accordance with a group financial support agreement if specific conditions listed in this article and article 23 BRRD are met.

Early intervention measures are, for instance, to require the management of the institution to implement measures set out in the recovery plan or to require the institution to remove and replace one or more members of the management if these persons are found unfit to perform their duties (article 27 et seq. BRRD). Competent authorities may appoint a temporary administrator to the institution and confer the powers of the management of the institution, including the power to exercise some or all of the administrative functions of the management of the institution (article 29 BRRD).

Member States shall ensure that resolution authorities take a resolution action to achieve the objectives listed in article 31 BRRD and in accordance with the principles defined in article

²²The ESRB is part of the European System of Financial Supervision (ESFS), which was implemented to ensure the supervision of the Union's financial system. Besides the ESRB, the ESFS comprises the EBA. For more information, see www.esrb.europa.eu. The legal text of the BRRD can be found on the website: <http://register.consilium.europa.eu/doc/srv?l=EN&f=PE%2014%202014%20REV%202> (20 May 2014).

34 BRRD if the resolution authority considers that all of the following conditions are met: the resolution authority has determined that the institution is failing or likely to fail; there is no reasonable prospect that any alternative private sector or supervisory action taken with respect to the institution would prevent the failure of the institution within a reasonable time frame; a resolution action is necessary in the public interest (article 32 BRRD). The resolution objectives are, for instance, to ensure the continuity of critical functions, to avoid significant adverse effects on financial stability and to protect public funds by minimising reliance on extraordinary public financial support (article 31 BRRD). The shareholders of the institution under resolution shall bear first losses, creditors of the institution under resolution bear losses after the shareholders, the management of the institution under resolution is replaced, unless their retention is considered necessary for the achievement of the resolution objectives, and "no creditor shall incur greater losses than would have been incurred if the institution...had been wound up under normal insolvency proceedings" (article 34 BRRD).

The resolution tools are the following (article 37 BRRD):

- the sale of business tool,
- the bridge institution tool,
- the asset separation tool,
- the bail-in tool.

When the resolution tools are used to transfer only part of the assets or liabilities of the institution under resolution, the residual institution shall be wound up under normal insolvency proceedings (article 37 BRRD). According to article 57 et seq. BRRD Member States may become a temporary shareholder of an institution.

Group level resolution authorities shall establish resolution colleges and cooperate with third countries (article 88 BRRD). Cooperation arrangements concluded between resolution authorities of Member States and third countries may include provisions such as the exchange of information necessary for the preparation and maintenance of resolution plans. The financing arrangements shall consist of: national financing arrangements, the borrowing between national financing arrangements and the mutualisation of national financing arrangements in the case of a group resolution (article 99 BRRD). Financing arrangements shall, in particular, have:

- the power to raise ex ante contributions,
- the power to raise ex post extraordinary contributions and
- the power to contract borrowings and other forms of support.

The financing arrangements may be used for the following purposes (among others): to guarantee the assets or the liabilities of the institution under resolution, to make loans to

Table 1.1: Prevention, early intervention and resolution measures

| Prevention (sound institution) | Early intervention (problem detected) | Resolution (failed or likely to fail) |
|--|--|---|
| <ul style="list-style-type: none"> - Stress tests - Resolution and recovery plans - Agreements between parent institutions and subsidiaries | <ul style="list-style-type: none"> - Recovery measures - Remove/replace management - Special managers | <ul style="list-style-type: none"> - Ordinary wind up - Sale of business - Bridge institution - Asset separation - Bail-in |

the institution under resolution, to purchase assets of the institution under resolution, to contribute capital to a bridge institution or an asset management vehicle (article 101 BRRD). The contribution of each institution shall be pro rata to the amount of its liabilities (excluding its own funds) minus covered deposits with respect to the aggregate liabilities (excluding its own funds), minus covered deposits of all the institutions authorised in the territory of the Member State (article 103 BRRD). Moreover, these contributions shall be adjusted in proportion to the risk profile of institutions. In the case of a group resolution, the national financing arrangement of each of the group entities, with respect to which resolution action is proposed, contributes to the financing of the group resolution (article 107 BRRD).

1.4.3 German level

By the implementation of the German Bank Restructuring Act (Figure 1.1), Germany already meets several requirements defined by international agreements. Further amendments are necessary due to the finalization of the BRRD. The German Bank Restructuring Act (RStruktG)²³, implemented 2010 and in force since January 2011, modified the German Banking Act (KWG)²⁴ as well as the Financial Market Stabilization Fund Act (FMStFG)²⁵ and implemented the Credit Institution Reorganization Act (KredReorG)²⁶ and the Restructuring

²³Gesetz zur Restrukturierung und geordneten Abwicklung von Kreditinstituten, zur Errichtung eines Restrukturierungsfonds für Kreditinstitute und zur Verlängerung der Verjährungsfrist der aktienrechtlichen Organhaftung (Restrukturierungsgesetz - RStruktG), BGBl. 2010 I, p. 1900, with subsequent amendments.

²⁴Gesetz über das Kreditwesen (Kreditwesengesetz - KWG), BGBl. 1998 I, p. 2776, with subsequent amendments.

²⁵Gesetz zur Errichtung eines Finanzmarktstabilisierungsfonds (Finanzmarktstabilisierungsfondsgesetz - FMStFG), BGBl. 2008 I, p. 1982, with subsequent amendments.

²⁶Gesetz zur Reorganisation von Kreditinstituten (Kreditinstitute-Reorganisationsgesetz - KredReorG), BGBl. 2010 I, p. 1900, with subsequent amendments.

Fund Act (RStruktFG)²⁷.

The KWG specifies general requirements for credit institutions, such as their rights and duties, and for the bank supervision. Moreover, it comprises measures for special situations, e.g. insolvency, and it regulates the restructuring and resolution of credit institutions. In the latter case, the KWG differentiates between systemic and non-systemic credit institutions. The RStruktG accounts for the potential failure of systemically relevant institutions. Its major aim is to guarantee the recovery or reorganization of credit institutions whose failure might cause severe disturbances in the proper functioning of the financial system.²⁸ The instruments should take cross-border banking into consideration and enable an internationally coordinated recovery or reorganization of multinational institutions.

The Credit Institution Reorganization Act regulates two kinds of procedures for institutions in trouble: a restructuring procedure ("Sanierungsverfahren") and a reorganization procedure ("Reorganisationsverfahren"). The difference between the restructuring and the reorganization procedure is, first, that only systemic banks can pursue a reorganization procedure and, second, that only in the latter procedure measures adopted can affect shareholders' and creditors' rights. The Credit Institution Reorganisation Act aims to achieve a consensus between supervisors, the credit institution and its creditors. It does not affect the powers of the Federal Financial Supervisory Authority (BaFin), including its right to apply for the initiation of insolvency proceedings under the Banking Act.

The Restructuring Fund was established with the Financial Market Stabilization Act, which was implemented in 2008 to stabilize the financial market. Pursuant to the Restructuring Fund Act (RStruktFG), all credit institutions have to contribute to the Fund by paying a levy on certain liabilities. The Fund can be used to establish bridge banks or acquire stakes in transferees, to issue guarantees or to recapitalize credit institutions. Details of the levy are regulated in the Restructuring Fund Regulation (RStruktFV)²⁹.

German Banking Act

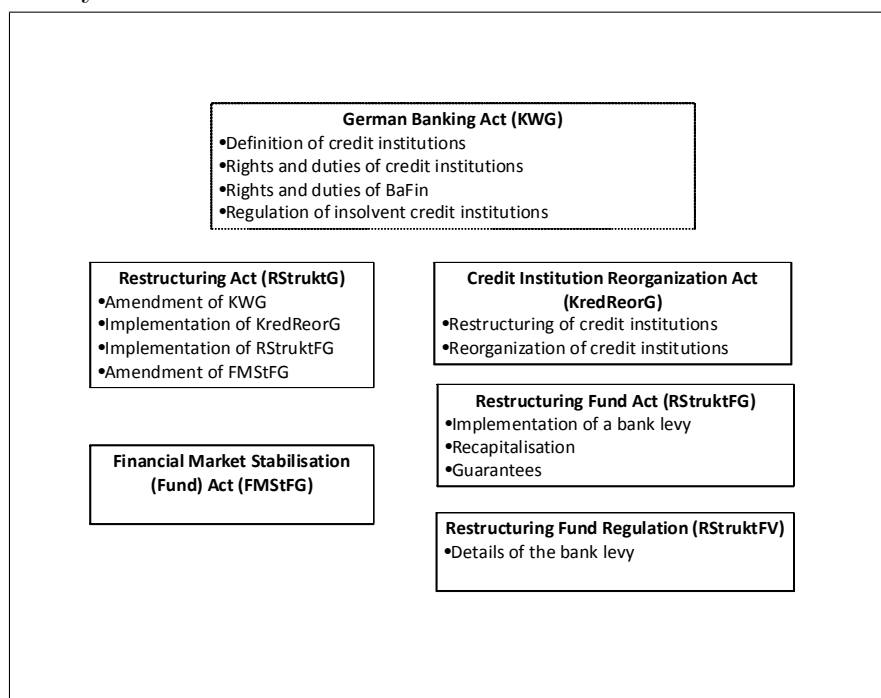
The German Banking Act regulates early intervention and resolution measures targeting insolvent credit institutions or institutions in trouble (section 45 et seqq. KWG). In case of liquidity or/and equity shortages, the Federal Financial Supervisory Authority ("Bundesanstalt für Finanzdienstleistungsaufsicht", BaFin) can order the institution to take measures to improve adequacy of its equity and liquidity. In particular, the BaFin can order the institution to consider measures to reduce material risks and to report to the BaFin and the Bundesbank to increase its equity and liquidity reserves (section 45 (1) and (2) KWG). If an institution's equity does not comply with the regulatory requirements, the BaFin is entitled to restrict or

²⁷ Gesetz zur Errichtung eines Restrukturierungsfonds für Kreditinstitute (Restrukturierungsfonds-gesetz - RStruktFG), BGBl. 2010 I, p. 1900, with subsequent amendments.

²⁸ See Deutscher Bundestag - Drucksache 17/3024.

²⁹ Verordnung über die Erhebung der Beiträge zum Restrukturierungsfonds für Kreditinstitute (Restrukturierungsfonds-Verordnung - RStruktFV), BGBl. 2011 I, p. 1406, with subsequent amendments.

Figure 1.1: Overview of bank recovery, reorganization, restructuring and resolution regulation in Germany



prohibit profit distributions and/or prohibit or restrict the granting of loans (section 45 (2) KWG). Moreover, the BaFin is allowed to instruct a special deputy who can be endowed with all the rights and duties of one or several managers (section 45c (1) and (2) KWG).

In case of debt overload, failure to pay or imminent failure to pay, insolvency proceedings begin (section 46b (1) KWG). Information sharing is required by section 46b (2) KWG, which forces the BaFin to inform the European Systemic Risk Board. Moreover, the BaFin informs regulators of other countries belonging to the European Economic Area (EEA) before a credit institution is in danger, especially if the failed credit institution has subsidiaries in these countries (section 46d (1) KWG). Therefore, information sharing is not only ensured if insolvency proceedings start, but already if a credit institution is likely to fail and recovery measures have to be applied. Section 46d (5) KWG forces the BaFin to support recovery measures of credit institutions which are located in another country of the EEA. section 46e (1) KWG clearly states that in the EEA the home country is responsible for the opening of insolvency proceedings. For example, if a multinational bank, located in Germany, has a subsidiary bank in Austria, the German authorities open insolvency proceedings of the multinational bank, while insolvency proceedings of the subsidiary bank are started by Austrian authorities.

Systemic banks have to develop a restructuring plan (i.e. a recovery plan) and to have it available (section 47 KWG). Accordingly, banks have to describe measures which are available in a restructuring scenario. Moreover, the plan must consider barriers to recovery and recovery triggers allowing for an early intervention by the credit institution. Guidance for the establishment of restructuring plans are provided by the Minimum Requirements for the De-

sign of Recovery Plans ("Mindestanforderungen an die Ausgestaltung von Sanierungsplänen", MaSan). The plan is complemented by a resolution plan which has to be developed by the competent authority, i.e. the BaFin (section 47f KWG). If the BaFin discovers potential barriers to the resolution of an institution, it is allowed to require measures which remedy such impediments (section 47e KWG). If an institution is insolvent and if it is not or no longer systemically relevant, an insolvency proceeding is started, according to the German Insolvency Act (section 46b KWG). Pursuant to section 47d KWG, it has to be ensured that all credit institutions are resolvable. Resolvability entails the transfer of assets and liabilities to a transferee. If such a transfer is ensured as a "measure of last resort", all credit institutions can pursue an insolvency proceeding.

Credit Institution Reorganisation Act

If the credit institution's management feels that restructuring is necessary, i.e. if the credit institution will in all likelihood not be able to meet its regulatory capital and/or liquidity requirements, it may notify the BaFin about the need for restructuring by presenting a restructuring plan and proposing a restructuring advisor. The plan can favour certain loans raised during the process of restructuring by giving preferential treatment to the creditors of loans in the potential insolvency procedure (section 2 KredReorG). The Higher Regional Court orders the recovery procedure to be conducted and appoints the proposed recovery adviser, provided the person who has been put forward is not obviously unsuitable (section 3 (1) KredReorG). The recovery adviser implements the recovery plan and is obliged to report regularly to the Higher Regional Court and BaFin on recovery progress. He has wide-ranging rights to obtain information and the right to issue instructions to senior management.

If restructuring fails, the institution may notify the BaFin about the need for reorganization by presenting a reorganization plan. BaFin can apply to the competent Higher Regional Court to carry out a reorganization procedure only if there is a going-concern risk to the credit institution pursuant to section 48b (1) KWG that results in a systemic risk pursuant to section 48b (2) KWG (section 7 (2) KredReorG). Reorganization can include conversion of debt into equity (section 9 KredReorG), transfer of assets to another institution (section 11 KredReorG) or even liquidation of a credit institution (section 8 (1) KredReorG). According to section 48a KWG, the BaFin can issue a "transfer order" if the stability of the financial system is threatened by a failed credit institution.³⁰ If this is the case, then (parts of) assets and liabilities are transferred to a transferee, e.g. a bridge bank. Immediately after the transfer order has become effective, the BaFin can withdraw the credit institution's license (section 48l KWG).

³⁰With regard to the systemic importance of a credit institution, section 48b KWG points to the interconnection with other financial institutions and to liabilities to other financial institutions. The systemic relevance is examined by the BaFin and the Bundesbank. See also guidance by the FSB, IMF and BIS, <http://www.imf.org/external/np/g20/pdf/100109a.pdf> (24 January 2014).

Restructuring Fund Act

The Restructuring Fund Act regularizes the scope of the institutions that have to pay a levy and the government of the fund. Pursuant to section 4 RStruktFG, the Federal Agency for Financial Market Stabilisation (FMSA) decides about the disposal of the funds in cooperation with the BaFin. All credit institutions with place of business in Germany and subsidiaries of institutions with place of business outside the EEA have to pay a levy (section 2 RStruktFG). For example, a subsidiary of an institution whose parent bank is located in Austria does not have to pay the levy. This exception avoids double taxation of banks located in the European Economic Area. This levy aims at building up a cushion of bank resolution or/and recovery funding and to capture the size and interconnectness of credit institutions.

The levy depends on the systemic relevance of an institution which is characterized by its size and interconnectness. Furthermore, it depends on all liabilities, except liabilities towards customers, jouissance right capital, funds for general bank risks and equity, and derivatives (section 1 (1) RStruktFV). The size is characterized by the assessment base (total assets) and the interconnectness by the fact that customer claims, for instance, do not affect the assessment base.³¹

The levy is the sum of liabilities multiplied by a certain factor which depends on the size of the bank (section 1 (1) RStruktFV). However, the levy must not exceed 20% of the annual profit determined in the income statement (section 3 (1) RStruktFV) and must not fall below 5% of the amount determined in section 1 (1) RStruktFV (section 3 (2) RStruktFV). Moreover, it must not be higher than three times the average of the three recent levies paid by the institution. The minimum amount always has to be paid, which is justified by the fact that credit institutions always benefit from the existence of a safety net, even if they do not pay any levy. The annual payment must not exceed 50% of the average annual profit of the recent years (section 3 (4) RStruktFV). In case the levy exceeds the reasonable amount determined in section 3 (1) and (2) RStruktFV, the institution has to pay the difference in the following years. However, the regular and the additional payment have to be in line with section 3 (4) RStruktFV. In order to avoid the circumvention of the payment, profit pooling and profit transfer do not decrease the assessment base (section 3 (1) RStruktFV).

³¹The German government justifies the inclusion of derivatives as they played an important role of contagion in the recent crisis (RStruktFV).

Chapter 2

Bank Levy and Bank Risk-Taking

2.1 Introduction

For many years, taxation of financial institutions was rather a side issue for tax and public finance economists. The current crisis and the need for large recapitalisation amounts for banks have changed this, and taxation for banks now forms part of a broader debate on regulatory reform (Beck (2011)). During the recent financial crisis, some major banks had to be bailed out in order to avoid a break-down of the financial system. Such bank bailouts are costly for at least two reasons. Firstly, they increase fiscal costs (Honohan & Klingebiel (2003)). Secondly, they may change the risk-taking incentives of banks. This is why the bailouts launched during the recent crisis caused a debate about who should bear the costs and how to prevent banks from gambling, as required by the G-20 on their summit in Toronto.¹ As a response, many countries, such as Germany, France, Sweden and United Kingdom have introduced a bank levy or a stability fee which forces banks to participate in the financing of crisis resolution measures.²

The motivation of banks to behave more prudently and the collection of funds for resolution scenarios may be achieved by various measures. Banks could be required to pay a systemic risk charge, which only addresses systemic banks in either form (Weder di Mauro (2010)). Shin (2010) suggests a tax on non-core liabilities which would lower banks' risk-taking incentives because non-core liabilities are more expensive than core liabilities. Perotti & Suarez (2009) suggest liquidity risk charges depending on the maturity of fundings because short-term uninsured liabilities induce fire sales in a crisis and thus increase financial distress. Gorton & Huang (2004) propose a tax on high-value, i.e. projects with a high payoff, but illiquid projects. Acharya, Pedersen, Philippon & Richardson (2013) propose a tax on systemic risk. Such a tax could be based on the expected loss a bank may incur in a financial crisis. Finally, regulators could tax financial transactions.

In the aftermath of the recent financial crisis, several countries announced to implement

¹<http://www.oecd.org/g20/meetings/toronto/g20-declaration.pdf> (16 March 2014).

²http://www.oecd.org/ctp/tax-policy/RS_SpecialFeature_2013_Classification%20of%20bank%20levies.pdf (24 January 2014).

a levy. However, the announced base for the levy differs from country to country. In Sweden and Germany, for instance, the levy is based on banks' liabilities (and derivatives). While in Sweden the levy has to be paid on total liabilities minus intra-group liabilities, in Germany, the levy is based on liabilities minus customer deposits and equity and on off-balance sheet derivatives. In Austria, the levy is based on capital assets and on derivatives. The scope of the levy also differs among these countries. While in Sweden, Germany and Austria only banks (credit institutions) are burdened, in the US other financial companies with assets exceeding a certain amount also have to pay a fee. In Hungary, the scope even includes insurance companies (Schich & Kim (2010)).

In Germany, the amount must not exceed a certain percentage of annual profit, but it must not fall below a certain minimum amount either (section 3 RStruktFV).³ Consequently, each credit institution has to pay an amount which is independent of its financial performance. Neglecting discount effects, such a minimum payment can be regarded as a pre-payment. We take such a pre-payment into consideration and ask whether its implementation alters banks' risk-taking behaviour. Moreover, we analyze the impact of a profit tax on banks' risk-taking as an alternative funding instrument and compare its effectiveness with the levy.⁴ In order to consider the possibility that banks may transfer the burden to depositors, we examine bank behaviour in a competitive environment.

The levy is required for banks and is based on the bank's debt level (e.g. deposits) as a proxy for their size.⁵ We use a similar framework as Repullo (2004), where banks compete in the market for secured debt (secured by an insurance, e.g. a deposit insurance) or unsecured debt and invest their funds in either a prudent or a gambling asset. Competition is modeled à la Hotelling (1929), where two firms (here: banks) are located at the end of a straight line and where customers (here: depositors) are continuously located on this line. We consider two scenarios. In the first scenario, banks compete in the market for debt which is insured ("secured debt"), while in the second scenario they compete in the market for "unsecured debt". The differentiation between secured and unsecured debt is important because unsecured creditors take the banks' risk-taking into account and therefore may influence the impact of a levy on banks' risk behaviour. Within the second scenario (unsecured debt), we consider two different patterns of information revelation: transparent and opaque banks. In the benchmark pattern, where banks are transparent, depositors can observe the banks' behaviour, while in the opaque case, the banks' investment behaviour is private information to the banks. In this case, depositors have to form beliefs about the banks' investment decision. We assume that the depositors' beliefs depend on the deposit rate offered by banks and that banks, offering a higher return for their customers, must engage in riskier assets in order to be able to pay them off. Therefore, if the offered deposit rate exceeds a certain threshold, depositors believe that banks gamble. Otherwise, the behaviour of the banks is seen as prudent.

³Banks have to pay a minimum levy. For more details, we refer the reader to Chapter 1.

⁴Among other instruments, a profit tax surcharge was suggested by the European Commission (2010) as an alternative to a bank levy.

⁵In Chapter 4, the levy will instead depend on the interconnectivity of banks.

We obtain the following results: A levy on secured debt can prevent banks from excessive risk behaviour if the regulator demands a pre-payment from the banks. Otherwise, their risk decision is not affected by the levy. This arises from the fact that a minimum payment ensures that banks have to pay the levy effectively if the project fails (otherwise depositors have to bear the costs). This induces banks to behave more prudently. Interestingly, even if the levy cannot be passed to depositors, it reduces moral hazard unless it exceeds a certain threshold. A levy on unsecured debt reveals a less clear picture because the impact of the levy on banks' risk-taking depends on whether banks are transparent or opaque. In the first case, banks always coordinate towards the prudent equilibrium and a bank levy does not change the banks' risk incentives, independent of whether the regulator requires a minimum levy or not. By contrast, the levy affects the equilibrium conditions of opaque banks. It decreases the range where banks gamble. A profit tax decreases risk-taking, too, though less effectively and only if the regulator demands that banks hold a minimum amount of equity capital.

This chapter proceeds as follows: Section 2.2 reviews the related literature. Section 2.3 introduces the model and Section 2.4 derives the impact of a bank levy on banks' risk behaviour if banks compete in the market for secured debt. Section 2.5 derives the impact of the levy on banks' risk-taking if banks compete in the market for unsecured debt. There, we differentiate between transparent and opaque banks. In Section 2.6, we extend our model and allow for alternative investments for creditors and compare the effectiveness of the levy with a profit tax. Section 2.7 concludes Chapter 2.

2.2 Literature review

There are several strands in the literature that are related to the model presented in this chapter. One strand analyzes the effects of taxes on bank profits. A second strand studies the relation between insurance premiums and banks' risk incentives. A third strand examines the impact of competition on the risk behaviour of banks.

Taxes on bank incomes may have the same effect as taxes on bank loans as they tend to increase interest rates on loans. This decreases investments from the corporate sector. The greater part of the burden is shifted to banks' customers (Albertazzi & Gambacorta (2010)). Similarly, Demirgüç-Kunt & Huizinga (1999) provide empirical evidence that corporate taxes (direct taxes on banks) are passed on to banks' customers and thus do not negatively impact banks' profits. However, the burden shift may not only take place in the case of direct taxes, such as income taxes, but also if indirect taxes, such as reserves on liabilities, are required (Fama (1985); James (1987)). However, these effects may differ between domestic and foreign banks. Since foreign banks may be able to offset tax payments by receiving tax credits from their home authority, customers of foreign banks are less burdened than customers from domestic banks, which influences profit differentials, too. Moreover, foreign banks may have more access to alternative investments outside the scope of local taxes (Demirgüç-Kunt & Huizinga (2001)). Besides, a tax on high-value but illiquid projects may avoid moral hazard. If liquidity is needed

at an earlier point in time, high-value projects cannot be monetized. The government may monetize these high value projects and provide liquidity to these banks by issuing bonds. A tax on these high-value projects guarantees a transfer from high-value projects to short-term projects. This ensures that a private liquidation market exists for troubled projects. Such a liquidation market is necessary in order to avoid moral hazard caused by banks which hold troubled projects (Gorton & Huang (2004)). Similarly, we analyse how charges on banks affect the banks' behaviour. However, the focus of the model described below is on the impact of a bank levy, but the effects of an income tax are examined, too. Like Demirgüç-Kunt & Huizinga (1999) and Albertazzi & Gambacorta (2010), we ask whether banks' customers have to pay the fee effectively. In contrast to Demirgüç-Kunt & Huizinga (2001), the model described below does not differentiate between domestic and foreign banks. This will be done in Chapters 4 and 5.

Insurance premiums are another form of charges on banks. An ex ante charged insurance premium may increase funding costs of banks, which decreases expected profit and thus lowers opportunity costs of risk-taking (Calem & Rob (1999)). They differentiate between well-capitalized and under-capitalized banks, where the risk premium surcharge depends on the bank's capitalization. A higher risk premium surcharge does not affect risk incentives of a well-capitalized bank. This arises from the fact that, on the one hand, a higher risk premium increases funding costs and thus decreases expected profits, but, on the other hand, it supports the capitalization of banks as the surcharge depends on the bank's capitalization, i.e. the higher the capitalization of a bank, the lower the risk premium. Calem & Rob (1999) provide examples where the latter effect offsets the cost effect. A risk-based deposit insurance may lower banks' risk incentives as the costs of risk-taking increase (Matutes & Vives (2000); Cordella & Yeyati (2002)). By contrast, a flat-premium deposit insurance, which charges banks' profits, may increase competition among banks and intensify gambling behaviour. The reason is that investors do not have incentives to punish banks' excessive risk-taking, as they are secured, and gambling behaviour is not punished through a higher risk premium (Matutes & Vives (2000)). The risk premium is not in the focus of the model described below. However, similar to the bank levy, it is a charge which has to be paid ex ante. As in the models of this strand, we focus on the relation between a charge on banks and the banks' risk-taking behaviour. A key ingredient of the model described below is competition among banks.

Our model is in line with various studies analysing the impact of competition on banks' risk-taking (Keeley (1990); Hellmann, Murdock & Stiglitz (2000); Boyd & De Nicoló (2005); Martinez-Miera & Repullo (2010)). This relationship is ambiguous since competition in the deposit market has effects on banks' risk-taking behaviour which are different from the effects of competition in the loan market. This ambiguity is also shown in empirical studies (Beck, Demirgüç-Kunt & Levine (2006); Jiménez, Lopez & Saurina (2007); Berger, Klapper & Turk-Ariss (2009)). In contrast to Boyd & De Nicoló (2005) and Martinez-Miera & Repullo (2010), we account for competition in the market for secured and unsecured debt. Similar to Matutes & Vives (1996), the depositors' expectations affect the banks' risk decision. In our model,

banks can influence the depositors' expectation by offering an adequate deposit rate. For an overview of the relation between bank competition and bank risk-taking, we refer the reader to Carletti (2008) and Beck, Coyle, Dewatripont, Freixas & Seabright (2010). The model described in the next section is closest to Repullo (2004) who examines the relation between minimum capital requirements and banks' risk-taking. In our model, this key ingredient in Repullo (2004) is replaced by a bank levy.

2.3 The model

2.3.1 Players and action sets

The model extends the results of Repullo (2004) by introducing a regulator who requires a levy on secured or unsecured debt. We consider the following groups of risk-neutral players: shareholders who own $n = 2$ banks, secured (unsecured) depositors, and a regulator who decides about the level of the levy ex ante. Each group of players only lives for one period, does not have alternative investment possibilities and desires to consume at the end of its life, i.e. at the end of the investment period, when the payoffs are distributed among shareholders and depositors. Henceforth we sometimes write "banks" (i.e. bank managers) instead of shareholders. As we do not take any principal-agent-problems into account, shareholders and banks have the same incentives. Hence, a differentiation between shareholders and banks is not necessary.

Banks

The two banks are located on the ends of a "street" of length one. At the beginning of the investment period (discrete time), shareholders invest an infinitesimal amount of equity capital in the bank. In excess of this infinitesimal amount of equity capital, shareholders have to pay a levy. This levy might be required ex ante (Section 2.4.1) or ex post of the bank's investment (Section 2.4.2). If this levy has to be paid ex ante, the shareholders have to pay the levy before the bank is allowed to invest. Shareholders have then invested the equity capital and the levy, but only the equity capital appears on the balance sheet, i.e. can be invested in projects by the bank. If this levy has to be paid ex post, shareholders only have to pay the infinitesimal amount equity capital before the bank is allowed to invest. In the ex post case, the levy has to be paid only if the bank's project has been successful.

Each bank j and $-j$ chooses its deposit rate r and either invests in a prudent asset or in a gambling asset.⁶ All characteristics of the prudent asset (e.g. return, probability of success) are indexed with " P ". The characteristics of the gambling asset are indexed with " G ". The balance sheet total of bank j consists of the infinitesimal amount of equity capital and deposits denoted by D_j .

⁶The equity capital investment does not have an impact on the banks' behaviour. The investment only clarifies that the banks are owned by shareholders who receive the net return of the investment.

The prudent investment yields a rate of return (henceforth we often write return) $\gamma^P \in (0, 1)$ with probability p^P and a return of zero, otherwise. The gambling investment generates a return $\gamma^G \in (0, 1)$ with probability p^G and a return of zero otherwise. Consequently, the banks can choose between a project with a relatively high return, but low probability of success, and a project with a relatively low return, but a high probability of success. The return function R can be summarized as follows, where R^G is the return for the gambling investment and R^P for the prudent investment:

$$\begin{aligned} R^G &= \begin{cases} \gamma^G & \text{with probability } p^G \\ 0 & \text{with probability } 1 - p^G \end{cases} \\ R^P &= \begin{cases} \gamma^P & \text{with probability } p^P \\ 0 & \text{with probability } 1 - p^P \end{cases} . \end{aligned}$$

We assume that the return of the gambling asset is higher than the return of the prudent asset, i.e. $\gamma^G > \gamma^P$, but the expected return of the gambling asset is lower, i.e. $p^P \gamma^P > p^G \gamma^G$. Limited liability of banks provides incentives to invest in the gambling asset and thus to cause moral hazard.

The residual of the project payoff (after depositors are paid) is distributed among the banks' shareholders. We further assume that shareholders have a time preference for consumption, which is represented by the discount factor $\delta > 0$.

Depositors

The depositors are continuously distributed on the "street".⁷ The aggregate market volume of deposits is constant to one. Depositing funds in a bank causes transportation costs per unit of distance, $\pi > 0$, which can be interpreted as the heterogeneity among banks. Imagine, for instance, that interest rates on deposits are not the only feature a customer takes into account when depositing his funds in a bank. Advisory services or/and the number of cashpoints might also play an important role for his decision. Following the cashpoint argument, we can assume that potential depositors are located between two cashpoints, owned by different banks, and customers choose the bank with the nearest one.

The amount of depositors that bank j attracts depends on its offered deposit rate, on the deposit rates offered by its neighbour and on the transportation costs π . We denote the deposit rate of bank j by $r_j \in (0, 1)$ and of bank j 's neighbour by r_{-j} . The banks' investment is private information and cannot be observed by depositors, except in Section 2.5.1. A depositor located between bank j and bank $-j$ is indifferent between these banks if he receives the same net return from both banks, i.e. if

$$r_j - \pi z = r_{-j} - \pi [1 - z] ,$$

⁷See also Freixas & Rochet (2008) who use an extended version with n banks.

where z is the distance between the indifferent depositor and bank j (or its cashpoint) and $1 - z$ the distance between the indifferent depositor and bank $-j$.⁸ We do not explicitly exclude negative net payoffs for depositors. This is in line with Repullo (2004). Solving for z reveals the "amount" (mass) of depositors on the line between bank j and $-j$ who decide to deposit their funds in bank j :⁹

$$z(r_j, r_{-j}) = D_j(r_j, r_{-j}) = \frac{1}{2} + \frac{r_j - r_{-j}}{2\pi}, \quad (2.1)$$

where $D_j(r_j, r_{-j}) \geq 0$ (a negative amount of depositors is impossible). The demand of deposits, D_j , decreases in π and r_{-j} and increases in r_j . The more heterogenous banks are, i.e. the higher the distance between the cashpoints (higher π), the less the impact of deposit rates on deposit demand.

Finally, the insurance premium is normalized to zero.¹⁰

Regulator

In the initial period, the regulator announces:

- the bank levy rate θ ,
- the minimum amount of equity kD_j each bank has to hold, where k is greater than the infinitesimal amount of equity (Section 2.6.2),
- the profit tax rate τ (Section 2.6.2).

D_j is supposed to be observable and verifiable. Hence, the announcement to require a levy is credible as both parties can sign a contract concerning the duty to pay the levy. If the project fails, shareholders receive zero payment and depositors are paid by the regulator unless they are unsecured.

2.3.2 Sequence of events

Figure 2.1 illustrates the sequence of events for the case, in which the levy has to be paid ex ante. At the beginning of the investment period, the regulator announces the bank levy rate (or the tax rate and the minimum amount of capital 2.6). Thereafter, the banks offer a deposit rate and decide about the type of investment simultaneously. Then, depositors choose a bank

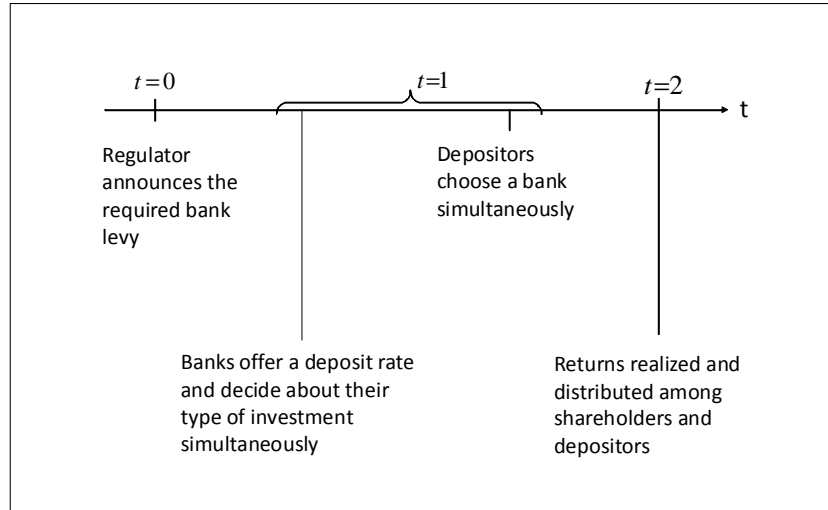
⁸Note that the comparison between transportation costs and returns is possible because of the normalization of payoffs and returns.

⁹Note that the demand of deposits does not depend on the banks' investment risk because deposits are covered by a deposit insurance.

¹⁰An insurance premium of zero is the extreme of an unfairly priced insurance. Unfairly priced means that the insurance premium is not equal to the expected payment of the insurance to the depositors. The introduction of a fairly priced insurance premium is impossible if several banks are insured and the characteristics of the banks are private information (Chan, Greenbaum & Thakor (1992)). For the impact of deposit insurance on risk-taking, see, for instance, Matutes & Vives (2000) and Cordella & Yeyati (2002).

in order to store their funds. Finally, payoffs are realized and distributed among depositors and shareholders.

Figure 2.1: Sequence of events



2.3.3 Equilibrium concept

We focus on symmetric equilibria: a prudent equilibrium, where both banks choose the prudent asset P and the optimal deposit rate in equilibrium r^P , and a gambling equilibrium, where both banks choose the gambling asset G and the optimal deposit rate in gambling equilibrium r^G . A prudent (a gambling) equilibrium, respectively, exists if neither bank j nor bank $-j$ has an incentive to deviate unilaterally by choosing the gambling (prudent) investment and the respective optimal deposit rate and if depositors do not have an incentive to change their decision about where to deposit their funds.

Competition between the banks only takes place in the deposit market because the investment of bank j does not have an impact on bank $-j$. We solve the game by backward induction, beginning with the second stage where depositors choose between bank j and bank $-j$. Taking the decision of depositors into account, we proceed with the first stage of the game where the banks decide simultaneously about the asset type and the deposit rate they offer. Since the banks choose their assets and the deposit rate simultaneously, they cannot observe their neighbour's choice.

2.4 The impact of a bank levy on banks' risk-taking in case of secured debt

2.4.1 Ex ante paid bank levy

The lower bound of the levy, as required by German law, is determined by the fact that each bank has to pay this amount ex ante, i.e. before it invests its funds, and is therefore independent of the outcome of its investment. The levy rate is denoted by θ . If the levy has to be paid ex ante, shareholders have to invest θD_j for each bank j in addition to the infinitesimal amount of equity. Such a minimum payment differs from the equity capital in as much as it cannot be invested in the project and hence does not generate a return.

Notice that we already solved the last stage of the game where depositors choose between bank j and bank $-j$ (2.1). Therefore, we can already proceed with the first stage of the game where banks choose their asset and the deposit rate. In order to be able to solve the game, we have to determine the payoffs in the potential equilibria and off (outside of) the equilibrium where bank j deviates unilaterally.

At the beginning of the investment period, bank j chooses the deposit rate r_j and the investment type $\gamma \in \{\gamma^P, \gamma^G\}$ in order to maximize its value V_j^l (the index "l" stands for "lower" bound), i.e. the net present value of expected profit minus levy. Before investing in either the prudent or the gambling asset, bank j has to pay the levy. In order to be able to determine the banks' asset choice, we have to ascertain the payoffs for the prudent and the gambling investment. Beginning with the prudent investment, the maximization problem of bank j in a symmetric prudent equilibrium is given by:

$$V_j^{lP} = \max_{r_j} [-\theta D_j^{lP}(r_j, r_{-j}) + \delta \Pi_j^{lP}(r_j, r_{-j})], \quad (2.2)$$

if it invests in the prudent assets. The expected period profit $\Pi_j^{lP}(r_j, r_{-j})$ amounts to:

$$\Pi_j^{lP}(r_j, r_{-j}) = p^P [\gamma^P - r_j] D_j^{lP}(r_j, r_{-j}). \quad (2.3)$$

$\gamma^P - r_j$ is the net return of the project. $\Pi_j^{lP}(r_j, r_{-j})$ is equivalent to the difference between expected gross payoff of investment $p^P (1 + \gamma^P) D_j^{lP}(r_j, r_{-j})$ and expected liabilities $p^P (1 + r_j) D_j^{lP}(r_j, r_{-j})$. Notice that the levy does not influence the expected profit because it has to be paid ex ante and in addition to the infinitesimal amount of equity.

The deposit rate in symmetric, and prudent equilibrium amounts to:

$$r^{lP} := \gamma^P - \pi - \frac{\theta}{\delta p^P}. \quad (2.4)$$

Notice that in the equilibrium, we can omit the indices j and $-j$. Obviously, r^{lP} increases in γ^P , p^P , δ and decreases in π and θ . In Section 2.6.1 we analyze a situation which does not

enable banks to offer their first-best deposit rate.

After inserting (2.4) into (2.2), we obtain:

$$V^{lP} = \delta p^P \frac{\pi}{2} \quad (2.5)$$

as the value of bank j (and equivalently the value of bank $-j$) in a prudent equilibrium. Accordingly, the bank value does not depend on the levy rate θ . The intuition is quite simple. As long as banks can pass the whole burden to depositors, a higher levy is compensated by a higher profit through a lower deposit rate (see 2.4).

In the same way, we can derive the bank value if both banks choose the gambling asset, where this investment is an equilibrium. In this case, the deposit rate is equal to:

$$r^{lG} := \gamma^G - \pi - \frac{\theta}{\delta p^G} \quad (2.6)$$

and the bank value is given by:

$$V^{lG} = \delta p^G \frac{\pi}{2}. \quad (2.7)$$

To derive the equilibrium conditions, we analyse under which conditions a unilateral deviation is not beneficial. Thus, we have a prudent equilibrium if

$$\max_{r_j} [-\theta D_j^{lG}(r_j, r_{-j}^{lP}) + \delta \Pi_j^{lG}(r_j, r_{-j}^{lP})] \leq V^{lP}.$$

The right side of the inequation represents bank j 's payoff if both banks choose the prudent asset (prudent equilibrium). The left side of the inequation represents the case where bank j deviates and chooses the gambling asset and the respective deposit rate, while bank $-j$ behaves prudently and offers r^{lP} , i.e. the optimal deposit rate in a symmetric prudent equilibrium.

Equivalently, we have a gambling equilibrium if

$$\max_{r_j} [-\theta D_j^{lP}(r_j, r_{-j}^{lG}) + \delta \Pi_j^{lP}(r_j, r_{-j}^{lG})] \leq V^{lG}.$$

The equilibrium condition can be found in the appendix. Proposition 1 summarizes the implication of a bank levy.

Proposition 1 *An increase in θ lowers the range where banks choose the gambling asset.*

Proof. See Appendix. ■

Although the bank values do not depend on the levy rate, the gambling area decreases in θ . The intuition is as follows: Depositors are charged effectively by the levy, but only if the project is successful. By contrast, if it fails, the levy is effectively paid by the banks themselves. Since the levy is paid in advance, the higher the levy, the more they can lose if the project fails. Consequently, a higher levy increases the banks' incentives to behave prudently.

2.4.2 Ex post paid bank levy

Alternatively to the bank levy, which has to be paid before the investment project is realized, a regulator may introduce a levy which has to be paid when project returns are realized. This, for instance, is the case when the regulator does not require a minimum levy. Then, the levy depends on whether the project is successful. If the profit is less than the levy θ , the banks do not have to pay anything, whereas if the profit exceeds the levy, they have to pay the full amount required by the regulator. In this case, bank j 's maximization problem can be written as:

$$V_j^P = \max_{r_j} [\delta p^P [\gamma^P - r_j - \theta] D_j^P(r_j, r_{-j})] \quad (2.8)$$

if the banks are in a symmetric prudent equilibrium. The deposit rate in a potential prudent equilibrium is then given by:

$$r^P := \gamma^P - \theta - \pi. \quad (2.9)$$

As a result, if $\delta p^P < 1$, the deposit rate in (2.4) is lower than in (2.9). Intuitively, the banks pass the potential loss (potential failure of the project) to the depositors and, therefore, depositors earn less if banks have to bear the levy ex ante. The bank value is the same as in (2.5), i.e. $V^P = V^{lP}$.

Similarly, in a symmetric equilibrium, where both banks gamble, bank j 's maximization problem is given by:

$$V_j^G = \max_{r_j} [\delta p^G [\gamma^G - r_j - \theta] D_j^G(r_j, r_{-j})]. \quad (2.10)$$

The deposit rate in a potential gambling equilibrium is equal to:

$$r^G := \gamma^G - \theta - \pi. \quad (2.11)$$

Again, the bank value is the same as in (2.7), i.e. $V^G = V^{lG}$.

Proceeding with the equilibrium conditions, banks behave prudently if

$$\max_{r_j} [\delta p^G [\gamma^G - r_j - \theta] D_j^G(r_j, r_{-j}^P)] \leq V^{lP},$$

i.e. if the expected profit of the deviating bank is lower than the expected profit it receives when it behaves prudently. Equivalently, banks gamble if

$$\max_{r_j} [\delta p^P [\gamma^P - r_j - \theta] D_j^P(r_j, r_{-j}^G)] \leq V^{lG}.$$

The equilibrium conditions are determined in the same way as in the previous section.

Proposition 2 *The levy θ does not have an effect on the banks' investment decision.*

Proof. See the proof of Proposition 1 in the appendix. The proof of Proposition 2 is equivalent. ■

The intuition is the following: The burden is completely passed to the depositors (see 2.9 and 2.11). Hence, banks do not have to bear the levy if profits are successful. Since the levy only has to be paid in case the project succeeds, banks never have to bear this burden. By contrast, if the levy has to be paid *ex ante*, banks have to bear the levy at least in case of failure. Consequently, as the levy does not affect the payoffs of the banks, it does not influence their investment decision.

2.5 The impact of a bank levy on banks' risk-taking in case of unsecured debt

Now depositors' expected returns depend on the project risks and therefore they take the banks' investment decision into account. As in Hakenes & Schnabel (2010), we differentiate between transparent and opaque banks. If banks are transparent, their risk decision is public information. By contrast, if they are opaque, their investment decision is private information. Then depositors have to form beliefs about the banks' investment decision. Whether banks are opaque or transparent with regard to their risk-taking is ambiguous in the literature (Hannan & Hanweck (1988), Avery, Belton & Goldberg (1988), Flannery & Sorescu (1996), Sironi (2003)). As a consequence, we consider both cases when determining the impact of the levy on banks' risk behaviour.

The levy is paid *ex ante*, i.e. as in Section 2.4.1.

2.5.1 Transparent banks

The timing is the same as in Figure 2.1. In contrast to the previous section, banks offer know an expected return. Due to the fact that the banks are transparent, this expected return can be enforced by legal action. We solve the game by backward induction, beginning with the last stage, where depositors decide where to deposit their funds. In contrast to the secured case, depositors take the expected net payment into account.

Beginning with the depositors' decision, a depositor receives the offered return r_j if bank j is successful, i.e. with probability p^G (gambling investment) or with probability p^P (prudent investment). Now depositors take the banks' investment decision into account, i.e. the expected return instead of the *ex post* return (previous chapter). Assume that both banks choose the prudent asset at the first stage of the game. Then the indifferent depositor receives:

$$p^P r_j - \pi z = p^P r_{-j} - \pi (1 - z).$$

After solving for z , we get the mass of depositors choosing bank j :

$$z(r_j, r_{-j}) = D_j^{TP}(r_j, r_{-j}) = \frac{1}{2} + p^P \frac{r_j - r_{-j}}{2\pi},$$

where the index " TP " stands for "transparent and prudent bank".

If banks choose the gambling asset, the indifferent depositor receives:

$$p^G r_j - \pi z = p^G r_{-j} - \pi (1 - z)$$

and therefore the mass of depositors who choose bank j amounts to:

$$z(r_j, r_{-j}) = D_j^{GT}(r_j, r_{-j}) = \frac{1}{2} + p^G \frac{r_j - r_{-j}}{2\pi},$$

where the index " GT " stands for "transparent and gambling bank". Equivalently, we can determine the deposit level of a deviating bank.

At the first stage of the game, banks decide about the deposit rates and the type of investment. We begin with the optimal deposit rate in the potential prudent equilibrium (symmetric) and proceed with the optimal rate in a potential gambling equilibrium (symmetric).

Assume that each bank has to pay a levy on its liabilities. Then, bank j 's maximization problem in a potential prudent equilibrium is given by:

$$V_j^{PT} = \max_{r_j} [-\theta D_j^{PT}(r_j, r_{-j}) + \delta \Pi_j^{PT}(r_j, r_{-j})], \quad (2.12)$$

where the expected period profit $\Pi_j^{PT}(r_j, r_{-j})$ amounts to:

$$\Pi_j^{PT}(r_j, r_{-j}) = p^P [\gamma^P - r_j] D_j^{PT}(r_j, r_{-j}). \quad (2.13)$$

The deposit rate in the potential (symmetric) prudent equilibrium is given by:

$$r^{PT} := \gamma^P - \frac{\theta}{\delta p^P} - \frac{\pi}{p^P} \quad (2.14)$$

which differs from (2.4) in as much as the impact of transportation costs is higher in (2.14) since $\pi < \frac{\pi}{p^P}$. Obviously, the deposit rate increases in the probability of success.

After inserting r^{PT} (2.14) in (2.12), we obtain the bank value in the prudent equilibrium:

$$V^{PT} = \delta \frac{\pi}{2}. \quad (2.15)$$

In the same way, we obtain the deposit rate in symmetric gambling equilibrium given by:

$$r^{GT} := \gamma^G - \frac{\theta}{\delta p^G} - \frac{\pi}{p^G}. \quad (2.16)$$

The bank value is $V^{GT} = V^{PT}$. In comparison with secured deposit rates in equilibrium (2.4), unsecured deposit rates are lower. To say it in a different way, although depositors can observe the banks' investment decision, the banks offer a lower deposit rate. If $\pi \rightarrow 0$, the deposit market is "very" competitive, i.e. transportation costs do not matter, and banks have to pass

the whole return to depositors. If $\pi > 0$, transportation costs matter. These costs matter more if depositors cannot be sure that they will be repaid by the banks. Hence, there are more possibilities for the banks to keep deposit rates low. By contrast, if deposits are secured, the probability of success affects the deposit rate, but not the probability of being remunerated. Therefore, transportation costs do not matter as much as in the unsecured case and the banks do not have the possibility of reducing the deposit rates comparably.

To determine the gambling equilibrium, we check whether a unilateral deviation pays, i.e. whether bank j chooses the prudent asset while the other banks gamble. Such a deviation is not beneficial if

$$\max_{r_j} [-\theta D_j^{PT}(r_j, r_{-j}^{GT}) + \delta \Pi_j^{PT}(r_j, r_{-j}^{GT})] \leq V^{GT},$$

where the optimal off-equilibrium deposit rate for the deviating bank equals:

$$r_j = \frac{r^{PT} + \frac{p^G}{p^P} r^{GT}}{2}. \quad (2.17)$$

After inserting the optimal deposit rate into the inequation (i.e. equilibrium condition), we obtain:

$$\frac{p^P r^{PT} - p^G r^{GT}}{2} + \frac{[p^P r^{PT} - p^G r^{GT}]^2}{8\pi} \leq 0$$

Since $p^P r^{PT} - p^G r^{GT} > 0$ and $\pi \geq 0$, this inequation does not have a solution (notice that $D > \frac{1}{2} > 0$ if the deviating bank offers a higher expected deposit rate). Consequently, r^{GT} (which is the unique candidate for a gambling equilibrium) cannot be the deposit rate in a gambling equilibrium. Of course, in this case no other candidate exists. The intuition is as follows: For the deviating bank, it is beneficial to offer a deposit rate which leads to a higher expected return for depositors. As the depositors can observe the investment decision, the higher expected return attracts more funds involving a higher bank value. In the previous section, the bank, which deviates from the gambling asset, offers a lower deposit rate and thus attracts fewer depositors. In that case, the benefit from a unilateral deviation depends on whether the lower deposit rate, i.e. the higher expected profit per depositor, outweighs the lower level of deposits.

In the same way, we can derive the conditions for a prudent equilibrium, where the following conditions must be fulfilled:

$$\max_{r_j} [-\theta D_j^{GT}(r_j, r_{-j}^{PT}) + \delta \Pi_j^{GT}(r_j, r_{-j}^{PT})] \leq V^{PT}. \quad (2.18)$$

The optimal deposit rate for the deviating bank equals:

$$r_j = \frac{r^{GT} + \frac{p^P}{p^G} r^{PT}}{2}. \quad (2.19)$$

After insterting (2.19) into (2.18), we obtain:

$$\frac{\pi}{2} \geq \frac{p^P r^{PT} - p^G r^{GT}}{8}.$$

Moreover, we must ensure that $D \geq 0$, which holds true if

$$\frac{\pi}{2} > \frac{p^P r^{PT} - p^G r^{GT}}{4}.$$

Since $D \geq 0$ is binding, a prudent equilibrium exists whenever the deviating bank offers a deposit rate which leads to a positive deposit level.

Proposition 3 *In a symmetric equilibrium, banks always choose the prudent asset if they are transparent.*

Proof. The proof has already been presented. ■

The intuition is the following: In a strategy combination, where all banks offer r^{GT} and gamble, banks always have an incentive to deviate unilaterally by offering a deposit rate which leads to a higher expected return for depositors. Since banks are transparent, depositors are aware of this higher expected return offered by the deviating bank. Hence, the deviating bank attracts more depositors because depositors "walk" to the bank which offers the highest expected return. This higher deposit volume offsets the higher expected deposit rate. If depositors are secured, depositors only look at the deposit return and, therefore, the deviating bank cannot pitch a safer investment to the depositors and the higher expected return offered by the deviating bank does not always attract more depositors.

By contrast, if all banks offer the deposit rate r^{PT} and behave prudently, no bank has an incentive to deviate and offer a lower expected deposit rate. Although the lower expected deposit rate would increase the bank's margin, this positive effect on net profit would be offset by the lower deposit volume. Hence, there is a prudent equilibrium where banks choose r^{PT} and behave prudently, whereas a gambling equilibrium does not exist.

As a result, since banks always behave prudently, the bank levy does not have an impact on their investment decision, independent of whether the regulator requires a minimum levy or not.

2.5.2 Opaque banks

If banks are opaque, depositors cannot observe the banks' investment decisions. Due to the fact that the investment decisions depend on the decisions of depositors who cannot observe the banks' investment decisions, we have to make assumptions on the depositors' behaviour. Similarly to Matutes & Vives (1996) depositors have certain homogeneous beliefs which are known to the banks. The equilibria of our model can be understood as perfect Bayesian equilibria (PBE) of a game with Bayesian depositors having prior (ex ante) beliefs. Two

requirements must be fulfilled at a PBE: (i) beliefs must be consistent, that is, the beliefs must equal the true investment, and (ii) banks must maximize expected profits, taking into account the updating rule followed by depositors. We assume the following posterior beliefs, i.e. the beliefs of depositors at their decision point (node):

$$\text{prob}(G \mid r \geq r^S) = 1$$

and

$$\text{prob}(G \mid r < r^S) = 0,$$

where the index "S" stands for "suspiciousness". To say it differently, if the deposit rate, offered by the bank, exceeds a deposit rate $r^S \geq 0$, which is exogenous and given ex ante, depositors believe that this bank gambles with probability one. If the deposit rate, offered by the bank, is lower than r^S , depositors believe that this bank gambles with probability zero. Consequently, depositors believe with probability one that the bank behaves prudently if the deposit rate, offered by this bank, is lower than r^S . They believe that banks behave prudently with probability zero if $r \geq r^S$.

In a similar setup, Niu (2008) assumes that subordinated (unsecured) creditors believe that banks gamble whenever they offer a deposit rate which differs from the deposit rate, offered to secured creditors in a potential prudent equilibrium. His framework contrasts to the setup presented here. In his framework banks raise secured deposits and issue subordinated debt, where subordinated creditors can observe the deposit rates offered by the banks to the secured creditors. The belief assumed in this section is in line with the core concepts of portfolio theory (capital asset pricing model) and the adverse selection in credit markets with imperfect information where high-risk borrowers can be identified because they prefer loan contracts with (lower collateral and) a higher interest rate (Stiglitz & Weiss (1981); Bester (1985)). Similarly in the setup here, depositors become suspicious and expect banks offering high deposit rates to invest in risky assets. While in Sections 2.4 and 2.5.1, deposit rates only serve to attract depositors, in this case, deposit rates serve as an instrument for banks to commit to a certain asset choice.

From the previous section, we already know the candidates for the deposit rates in a potential prudent and a potential gambling equilibrium: r^{PT} and r^{GT} . Notice that the depositors base their decision on the expected return and on the transportation costs in the same way as in the transparent case. However, in the gambling case, this deposit rate is only consistent with depositors' beliefs if $r^S \leq r^{GT}$. Otherwise, r^{GT} causes depositors to believe that the banks behave prudently and banks have a beneficial deviation possibility with regard to r^{GT} . Equivalently, r^{PT} can only be the deposit rate in a prudent equilibrium if $r^S > r^{PT}$. Finally, we assume that the depositors do not wish to be fooled.

Again we determine the equilibrium conditions by examining whether a unilateral deviation is beneficial. The equilibrium conditions can be determined in the same way as in Sections 2.4 and 2.5.1.

Proposition 4 *The existence of a gambling and a prudent equilibrium depends on the level of r^S in such a way that*

(a) *a gambling equilibrium exists if*

$$r^S \leq \frac{r^{PT} + \frac{p^G}{p^P} r^{GT}}{2} - \frac{\sqrt{[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi}}{2p^P} =: m^G,$$

(b) *a prudent equilibrium exists if*

$$r^S \geq \frac{p^G}{p^P} r^{GT} - 2 \frac{\sqrt{\pi [p^P r^{PT} - p^G r^{GT}]}}{p^P} =: m^P,$$

(c) *We have*

$$m^G > m^P.$$

Proof. The proof can be found in the appendix. ■

As a result, in contrast to the transparent case, a gambling equilibrium exists if $r^S \leq m^G$ is sufficiently small. Intuitively, if r^S is sufficiently low, the banks can offer their first-best deposit rate in a potential gambling equilibrium, i.e. r^{GT} . Due to the fact that r^S is low, a unilateral deviation from the gambling path is costly because depositors only believe that the deviating bank behaves prudently, if it offers a deposit rate which is lower than r^S . Such a low deposit rate only attracts few depositors which are located sufficiently close to the deviating bank. A prudent equilibrium only exists if r^S is sufficiently high. In this case, a deviation from the prudent path is costly because the deviating bank has to offer an even higher deposit rate. This may attract more depositors, but lowers the expected net profit. The latter effect dominates if $r^S \geq m^P$.

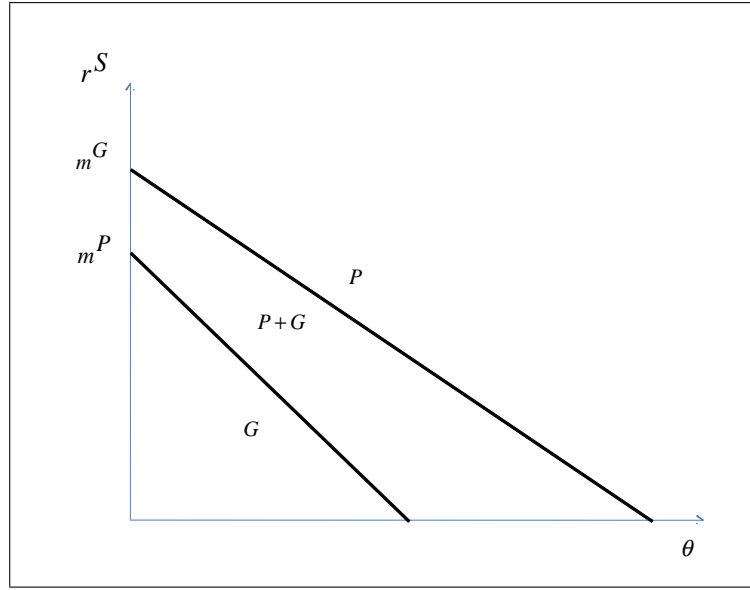
A low threshold r^S may be an indicator for mistrust (suspiciousness) towards banks. Interestingly, this mistrust leads to the fact that banks gamble. This result is in line with the theory of self-fulfilling expectations.

It is easy to show that $p^P r^{PT} + p^G r^{GT}$ decreases in θ . Therefore, a higher bank levy decreases the range where banks gamble. Figure 2.2 illustrates the equilibrium conditions in case of opaque banks. Notice that the decrease of m^G in θ is lower in absolute terms.

2.6 Discussion

Throughout this section we return to the assumption that bank deposits are secured by a deposit insurance like in Section 2.4. Hence, it does not play a role whether banks are opaque or transparent because depositors receive their return independently of whether the project is successful or fails.

Figure 2.2: Equilibria in the opaque case



2.6.1 Opportunity costs

The effect of the bank levy might change if we introduce opportunity costs for depositors. For example, they might be able to invest in alternative assets without risk. To see how the results change, assume that only depositors have an alternative investment opportunity with risk-free return denoted by $r^{opp} > 0$. This interest rate can be interpreted as the opportunity costs for depositors who invest in the banks. The index "opp" stands for "opportunity costs". According to the level of the risk-free interest rate, we assume $\gamma^P - \pi = r^{opp}$ and $\gamma^G - \pi - \frac{\theta}{\delta p^G} < r^{opp} < \gamma^G - \pi$. Consequently, independent of the investment type, banks cannot pass the whole burden of the levy to depositors. While banks choosing the gambling asset can pass a part of the levy to depositors, banks choosing the prudent asset have to bear the whole levy. Hence in both cases, the optimal deposit rate is r^{opp} and the levy lowers the bank values V^{oppP} and V^{oppG} .

To see this, we start again with the determination of bank values depending on the type of asset. In the case where all banks gamble, bank j 's maximization problem equals:

$$\max_{r_j} \left[-\theta D_j(r_j, r_{-j}) + \delta p^G [\gamma^G - r_j] D(r_j, r_{-j}) \right], \quad (2.20)$$

This leads to the equilibrium rate:

$$r_j = \gamma^G - \pi - \frac{\theta}{\delta p^G} < r^{opp}.$$

Since r^{opp} is binding, banks choose r^{opp} . Inserting this deposit rate into the objective function

(2.20) leads to the following bank value if all banks choose the same risky asset:

$$V^{oppG} = [\delta p^G \phi - \theta] \frac{1}{2} + \delta p^G \frac{\pi}{2},$$

where $\phi := \gamma^G - \pi - r^{opp}$. That is, ϕ is the difference between the optimal deposit rate in equilibrium for $\theta = 0$ and the depositors' alternative investment r^{opp} . Therefore, the bank value only decreases by $\delta p^G \mu - \theta$. If $\delta p^G \mu = \theta$, bank j can pass the whole burden to depositors and we obtain the same result as above.

In the case where all banks behave prudently, bank j 's maximization problem is given by:

$$\max_{r_j} [-\theta D_j(r_j, r_{-j}) + \delta p^P \bar{v} [\gamma^P - r_j] D(r_j, r_{-j})], \quad (2.21)$$

and the equilibrium rate equals:

$$r_j = \gamma^P - \pi - \frac{\theta}{\delta p^P} < r^{opp}.$$

Since r^{opp} is binding, bank j chooses r^{opp} . Inserting the equilibrium rate into the objective function (2.21), we obtain:

$$V^{oppP} = -\frac{1}{2}\theta + \delta p^P \frac{\pi}{2}.$$

In contrast to the gambling case, banks in the prudent case have to bear the whole burden imposed by regulators. Henceforth, we assume that bank values fulfill $V^{oppG} \geq 0$ and $V^{oppP} \geq 0$.

We have a gambling equilibrium if

$$\max_{r_j} [-\theta D_j(r_j, r^{opp}) + \delta p^P [\gamma^P - r_j] D_j(r_j, r^{opp})] \leq V^{oppG},$$

where the optimal deposit rate for the deviating bank amounts to:

$$r_j = r^{opp} - \frac{1}{2} \frac{\theta}{\delta p^P} =: r_j^{G*}.$$

However, since $r_j \geq r^{opp}$, the optimal deposit rate is still r^{opp} , i.e. the lowest possible rate.

Equivalently, we have a prudent equilibrium if

$$\max_{r_j} [-\theta D_j(r_j, r^{opp}) + \delta p^G [\gamma^G - r_j] D_j(r_j, r^{opp})] \leq V^{oppP},$$

where the optimal deposit rate amounts to:

$$r_j = \frac{\gamma^G - \frac{\theta}{\delta p^G} - \pi + r^{opp}}{2} =: r_j^{P*}.$$

Since $\gamma^G - \frac{\theta}{\delta p^G} - \pi < r^{opp}$ we have $r_j^{P*} < r^{opp}$ and, therefore, the optimal deposit rate is

again given by r^{opp} .

Proposition 5 *With positive opportunity costs r^{opp} , we obtain the following equilibrium conditions:*

- Banks choose the gambling asset if

$$\phi \geq \frac{[p^P - p^G] \pi}{p^G} \frac{\pi}{2} =: \phi^{crit}.$$

- Otherwise they invest in the prudent asset.

Proof. The derivation of the equilibrium conditions follows the same pattern as described for Proposition 1 in the appendix. ■

Accordingly, we do not have multiple equilibria and the effect of the levy on risk behaviour changes. If banks cannot pass the burden to depositors, deposit rates are always the same, even for a unilaterally deviating bank. Therefore, deviating in order to attract more depositors does not pay. However, as deposit rates in the gambling case are higher than in the prudent case, gambling banks can pass a higher part of the burden to depositors than prudent banks. If this part is sufficiently high, i.e. $\phi \geq \phi^{crit}$, banks prefer the gambling asset. Otherwise, they behave prudently.

2.6.2 Comparison between bank levy and bank profit tax

At the end of the investment period, banks have to pay a profit tax, which is denoted by τ . Accordingly, each bank can only retain $1 - \tau$ of the profit. In this section, we introduce a minimum capital requirement $k > 0$. If banks do not have to hold a minimum amount of equity capital, a profit tax does not change the banks' investment decision. Therefore, we have to introduce a minimum amount of equity. The way of modelling such a capital requirement is in line with Repullo (2004). Under this model, the maximization problem of bank j (all banks behave prudently) can be described as (the index " τ " stands for "tax"):

$$V_j^{\tau P} = \max_{r_j} [-k D_j^{\tau P}(r_j, r_{-j}) + (1 - \tau) \delta \Pi_j^{\tau P}(r_j, r_{-j})]. \quad (2.22)$$

The expected profit $\Pi_j^{\tau P}$ can be written as:

$$\Pi_j^{\tau P} = p^P ([1 + \gamma^P] [1 + k] - [1 + r_j]) D_j^{\tau P}(r_j, r_{-j}),$$

where $[1 + \gamma^P] [1 + k] D_j^{\tau P}(r_j, r_{-j})$ is the payoff of the project and $[1 + r_j] D_j^{\tau P}(r_j, r_{-j})$ the liability which has to be paid back.

The equilibrium rate amounts to:

$$r^{\tau P} := \gamma^P - \pi + k \left[1 + \gamma^P - \frac{1}{(1 - \tau) \delta p^P} \right]. \quad (2.23)$$

According to (2.23), an increase in τ decreases the deposit rates. The tax rate does not affect $r^{\tau P}$ for $k = 0$.

Inserting (2.23) in (2.22) leads to the following bank value $V_j^{\tau P}$:

$$V^{\tau P} = (1 - \tau) \delta p^P \frac{\pi}{2}. \quad (2.24)$$

Obviously, the bank value decreases if the tax ratio increases. In contrast to the levy, depositors and shareholders share the tax payment because shareholders have to pay the tax on their net return $\gamma - r$. The value $V^{\tau P}$ does not depend on the capital requirement k because the banks adjust the deposit rates.

Equivalently, if all banks gamble, the deposit rate for bank j equals:

$$r^{\tau G} := \gamma^G - \pi + k \left[1 + \gamma^G - \frac{1}{(1 - \tau) \delta p^G} \right] \quad (2.25)$$

and the bank value amounts to:

$$V^{\tau G} = (1 - \tau) \delta p^G \frac{\pi}{2}. \quad (2.26)$$

To be able to compare the effect of a profit tax and a bank levy, we have to introduce a minimum amount of equity k into our levy model. If the banks have to pay a levy ex ante and if they are required to hold a minimum amount of equity k , bank i 's maximization problem in the prudent case can be described by:

$$\bar{V}_j^{lP} = \max_{r_j} \left[- (k + \theta) \bar{D}_j^{lP}(r_j, r_{-j}) + \delta \bar{\Pi}_j^{lP}(r_j, r_{-j}) \right]. \quad (2.27)$$

This objective function differs from (2.2) only in k . In Section 2.4.1, k is infinitesimal. The expected profit can be written as:

$$\bar{\Pi}_j^{lP} = p^P \left([1 + \gamma^P] [1 + k] - [1 + r_j] \right) \bar{D}_j^{lP}(r_j, r_{-j}).$$

The deposit rate in a potential prudent equilibrium equals:

$$\bar{r}^{lP} := \gamma^P - \pi - \frac{\theta}{\delta p^P} + k \left[1 + \gamma^P - \frac{1}{\delta p^P} \right]. \quad (2.28)$$

The deposit rate \bar{r}^{lP} differs from (2.4) in $k \left[1 + \gamma^P - \frac{1}{\delta p^P} \right]$. Inserting (2.28) in (2.27), leads to the same prudent value as in (2.5) because k is passed on to the depositors (see 2.28).

In the equivalency way, we can determine the deposit rate in a potential gambling equilibrium:

$$\bar{r}^{lG} := \gamma^G - \pi - \frac{\theta}{\delta p^G} + k \left[1 + \gamma^G - \frac{1}{\delta p^G} \right].$$

Similarly to the prudent case, the value of the gambling bank in the potential gambling

equilibrium is the same as (2.7).

The equilibrium conditions are determined in the same ways as in the Appendix "Proof of Proposition 1".

Proposition 6 *Similarly to a bank levy, a profit tax can decrease the risk-taking of banks. An increase in the tax rate τ decreases the range in which all banks gamble. The risk-reducing effect of a profit tax increases in the minimum capital requirement k . In comparison with the profit tax, a bank levy is more effective in preventing excessive risk-taking only if the regulator requires a minimum levy.*

Proof. The equilibrium conditions in the tax case and the levy case only differ in their deposit rate differential. We immediately see that $\bar{r}^{lG} - \bar{r}^{lP} < r^{\tau G} - r^{\tau P}$ for $k = 0$. Moreover, the decrease of $\bar{r}^{lG} - \bar{r}^{lP}$ in k is smaller in absolute terms than the decrease of $r^{\tau G} - r^{\tau P}$ because

$$\frac{1}{\delta p^G} - \frac{1}{\delta p^P} < \frac{1}{(1-\tau)\delta p^G} - \frac{1}{(1-\tau)\delta p^P}$$

which is equivalent to:

$$p^P > p^G.$$

■

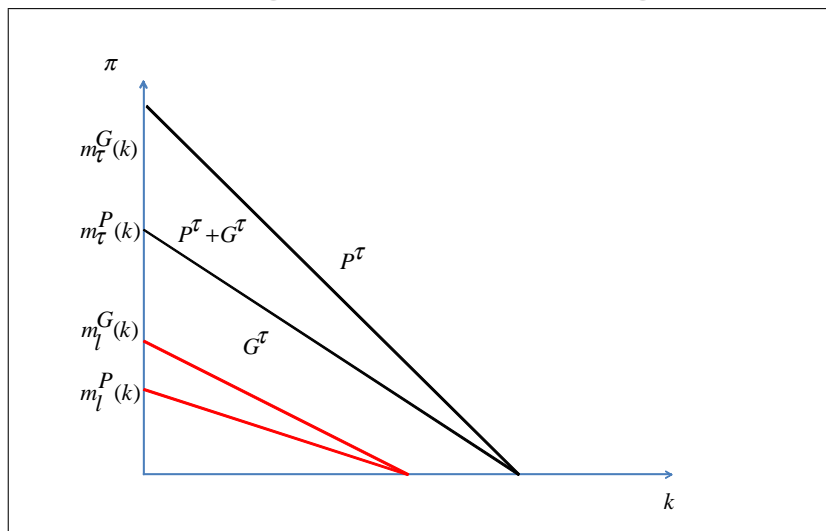
For $k = 0$, the profit tax does not have an effect on the equilibrium conditions. The tax rate reduces bank values in absolute terms, but not in relative terms. Moreover, for $k = 0$, the profit tax does not change optimal deposit rates. As a result, the payoff of a deviating bank does not change in τ , which leads to the fact that the incentives to deviate unilaterally remain unchanged. Therefore, the equilibrium conditions are not affected by τ .

By contrast, if $k > 0$, the profit tax matters because it changes deposit rates which, in turn, alters the equilibrium conditions. The reason is the following: Assume that all banks invest in the prudent asset. A deviating bank then requires a higher compensation for the tax on equity capital return (to receive a payoff which is at least as high as opportunity costs), which attracts fewer depositors and thus reduces profit. Hence, banks have fewer incentives to deviate. Assume, by contrast, that banks choose the gambling asset. Then a deviating bank requires less compensation for the tax on equity capital which attracts more depositors and thus increases the profit. Consequently, banks have stronger incentives to deviate.

Figure 2.3 illustrates the risk-reducing effect of a profit tax and a bank levy for $\tau = \theta$.¹¹, where the bank levy is paid ex ante. In case of a bank levy, a gambling equilibrium exists if $\pi \leq m_l^G(k)$, and a prudent equilibrium if $\pi \geq m_l^P(k)$. Notice that $m_l^G(k)$ and $m_l^P(k)$ define the equilibrium conditions. We dispense with their explicit derivation. In case of a profit tax, a gambling equilibrium exists if $\pi \leq m_\tau^G(k)$, and a prudent equilibrium exists if $\pi \geq m_\tau^P(k)$. In order to avoid complexity, only the equilibria in the tax case are labeled in the figure (P^τ and

¹¹Recall that we normalized the payoffs and returns, which allows a comparison between the effectiveness of a bank levy and a profit tax.

Figure 2.3: Equilibria: Bank levy versus profit tax



G^τ). These equilibrium conditions can be determined in the same way as in the appendix of Proposition 1. Figure 2.3 shows that a bank levy depending on the level of liabilities is more effective than a profit tax if the regulator is only concerned about the investment risk. This is due to the fact that in case of a bank levy, the whole burden is passed to depositors. By contrast, in case of a profit tax, only part of the burden is borne by depositors.

2.7 Conclusion

We determined the effect of two possibilities for funding government bailouts on the risk behaviour of banks: a bank levy on deposits and a profit tax. The paper accounts for competition in the deposit market by using the imperfect competition framework à la Hotelling (1929). The banks fund their assets with secured deposits and invest in either a prudent or a gambling project. High competition leads to an equilibrium where all banks gamble, whereas a prudent equilibrium exists if the number of banks is sufficiently low. Our results suggest that both a levy on deposits and a profit tax can induce banks to switch from gambling to prudent assets. While a bank levy is completely passed on to depositors, a profit tax is partially borne by banks' shareholders. Consequently, a bank levy is relatively more effective in decreasing the risk level of banks.

The effectiveness of the levy depends upon whether the regulator can force the bank to pay the levy *ex ante*, i.e. before the funds are invested. In this case, they bear the risk of paying the levy effectively and, therefore, they have larger incentives to behave prudently. The implementation of a minimum levy may fulfill this requirement because the banks have to ensure that they are always sufficiently liquid in order to be able to pay the bill. Apart from such a minimum requirement, other instruments may be available. However, the regulators always have to ensure that the banks share at least a part of the burden effectively. Moreover,

the levy must neither be too small nor too large. In the former case, the banks' potential loss is too small to be able to affect banks' behaviour (Buch, Hilberg & Tonzer (2013)). In the latter case, the banks' margins decrease to such a degree that they have even higher incentives to gamble. Consequently, when the authorities wish to generate funds from the banks and to influence the banks' risk-taking, finding the optimal instrument and the optimal fee can be quite difficult.

Appendix

Proof of Proposition 1

Gambling equilibrium

We have to solve the following inequation (see main text):

$$\max_{r_j} [-\theta D_j^{lP}(r_j, r_{-j}^{lG}) + \delta \Pi_j^{lP}(r_j, r_{-j}^{lG})] \leq V^{lG}. \quad (2.29)$$

First of all, we have to determine the optimal deposit rate of the deviating bank. This bank chooses:

$$r_j = \frac{r^{lG} + r^{lP}}{2}. \quad (2.30)$$

After inserting this deposit rate into (2.29), we obtain:

$$\delta p^P \left[\gamma^P - \frac{\theta}{\delta p^P} - \frac{r^{lG} + r^{lP}}{2} \right] \left[\frac{1}{2} + \frac{\frac{r^{lG} + r^{lP}}{2} - r^{lG}}{2\pi} \right] \leq V^{lG},$$

which is equivalent to:

$$4\pi^2 \left[1 - \frac{p^G}{p^P} \right] - 4\pi [r^{lG} - r^{lP}] + [r^{lP} - r^{lG}]^2 \leq 0.$$

The solution of this inequation is given by:

$$\frac{r^{lG} - r^{lP}}{2 \left[1 + \sqrt{\frac{p^G}{p^P}} \right]} \leq \pi \leq \frac{r^{lG} - r^{lP}}{2 \left[1 - \sqrt{\frac{p^G}{p^P}} \right]}. \quad (2.31)$$

However, we must ensure that the debt level of the deviating bank is not negative, i.e. that:

$$\pi \geq \frac{r^{lG} - r^{lP}}{2}.$$

Hence, if the deposit rate is positive, π exceeds the lower bound in (2.31). Consequently, we can neglect the lower bound. Since $r^{lG} - r^{lP}$ decreases in θ (see 2.4 and 2.6), a higher levy lowers the area where banks gamble.

Prudent equilibrium

We have to solve the following inequation (see main text):

$$\max_{r_j} [-\theta D_j^{lG}(r_j, r_{-j}^{lP}) + \delta \Pi_j^{lG}(r_j, r_{-j}^{lP})] \leq V^{lP}. \quad (2.32)$$

Again, we first have to determine the optimal deposit rate for the deviating bank. It is easy to show that the deposit rate is the same as in (2.30). After inserting this deposit rate into

(2.32), we obtain:

$$\delta p^G \left[\gamma^G - \frac{\theta}{\delta p^G} - \frac{r^{lG} + r^{lP}}{2} \right] \left[\frac{1}{2} + \frac{\frac{r^{lG} + r^{lP}}{2} - r^{lP}}{2\pi} \right] \leq V^{lP}.$$

Simple rearrangements lead to:

$$4\pi^2 \left[\frac{p^P}{p^G} - 1 \right] - 4\pi [r^{lG} - r^{lP}] - [r^{lG} - r^{lP}]^2 \geq 0.$$

The solution of this inequation is given by:

$$\pi \leq -\frac{r^{lG} - r^{lP}}{2 \left[1 + \sqrt{\frac{p^P}{p^G}} \right]} \text{ or } \pi \geq \frac{r^{lG} - r^{lP}}{2 \left[\sqrt{\frac{p^P}{p^G}} - 1 \right]}.$$

However, remember that $\pi > 0$. Consequently, a higher θ lowers $r^{lG} - r^{lP}$ and, therefore, increases the range within which banks behave prudently.

Proof of Proposition 2

The bank levy affects the equilibrium conditions again through its effect on the difference between deposit rates r^G and r^P . However, since $r^G - r^P$ does not depend on θ (see 2.9 and 2.11), a bank levy does not influence the investment decision of banks in equilibrium.

Proof of Proposition 4

When we identify the equilibrium conditions, we check whether a unilateral deviation from the potential equilibrium path is beneficial. We only allow from deviations which are consistent with depositors' beliefs. The rationale for this constraint is the following: Consider a bank that deviates unilaterally from the potential prudent equilibrium path and offers a deposit rate which makes depositors believe that it still behaves prudently although it aims to invest in the gambling asset. Depositors know that this offer is only optimal for the deviating bank if they believe that the bank still invests in the prudent asset. Remember that the depositors are aware of the banks' objective functions. If the depositors do not want to be fooled, they do not offer their deposit rate to this deviating bank. This, in turn, is known by the banks and, therefore, they will not offer such a deposit rate.

Conditions for a gambling equilibrium

We already know from the transparent case that r^{GT} is a candidate for the deposit rate in equilibrium. To determine the equilibrium conditions, we have to examine whether a unilateral deviation is beneficial for any bank. For didactic reasons, it may be worthwhile to differentiate between two cases:

1. $r^S < r^{GT}$
2. $r^S > r^{GT}$.

Case 1 Since r^{GT} exceeds r^S , r^{GT} could be a candidate for the deposit rate in equilibrium. A gambling equilibrium where banks offer r^{GT} exists if the following condition is fulfilled:

$$\max_{r_j} \left[\delta p^P \left[\gamma^P - \frac{\theta}{\delta p^P} - r_j \right] \left[\frac{1}{2} + \frac{p^P r_j - p^G r^{GT}}{2\pi} \right] \right] \leq \delta \frac{\pi}{2},$$

where $\delta \frac{\pi}{2}$ is the bank value in a potential gambling equilibrium. Notice that depositors expect the deviating bank to invest in the prudent asset. From the transparent case, we already know that a deviating bank prefers (see 2.17):

$$r_j = \frac{r^{PT} + \frac{p^G}{p^P} r^{GT}}{2}. \quad (2.33)$$

If $r_j < r^S$, this deposit rate is consistent with the depositors' belief. Then, we already know from the transparent case that such a deviation is always beneficial, i.e. that we do not have a gambling equilibrium.

However, if $r_j > r^S$, the deviating bank cannot choose r_j , but has to offer at least r^S . Of course, r^S is then the optimal choice for the deviating bank. In this case, a unilateral deviation is not beneficial if

$$\delta p^P \left[\gamma^P - \frac{\theta}{\delta p^P} - r^S \right] \left[\frac{1}{2} + \frac{p^P r^S - p^G r^{GT}}{2\pi} \right] \leq \delta \frac{\pi}{2}.$$

Recall that $r^{PT} := \gamma^P - \frac{\theta}{\delta p^P} - \frac{\pi}{p^P}$. Hence, the equilibrium condition is equivalent to:

$$p^P \left[r^{PT} - r^S + \frac{\pi}{p^P} \right] \left[\frac{1}{2} + \frac{p^P r^S - p^G r^{GT}}{2\pi} \right] \leq \frac{\pi}{2}.$$

Rearrangements lead to:

$$0 \leq [p^P r^S]^2 - [p^P r^{PT} + p^G r^{GT}] p^P r^S + [p^G r^{GT} - p^P r^{PT}] \pi + p^P r^{PT} p^G r^{GT}. \quad (2.34)$$

The corresponding equation has the following solutions:

$$[p^P r^S]_{1/2} = \frac{[p^P r^{PT} + p^G r^{GT}] \pm \sqrt{[p^P r^{PT} + p^G r^{GT}]^2 - 4[p^G r^{GT} - p^P r^{PT}] \pi + p^P r^{PT} p^G r^{GT}}}{2},$$

where

$$[r^S]_1 = \frac{[p^P r^{PT} + p^G r^{GT}] - \sqrt{[p^P r^{PT} + p^G r^{GT}]^2 - 4[p^G r^{GT} - p^P r^{PT}] \pi}}{2p^P}$$

and

$$[r^S]_2 = \frac{[p^P r^{PT} + p^G r^{GT}] + \sqrt{[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi}}{2p^P}.$$

The inequation (2.34) is fulfilled if

$$r^S < [r^S]_1 \text{ or } r^S > [r^S]_2.$$

However, remember that we are in the case, in which $r_j = \frac{r^{PT} + \frac{p^G}{p^P} r^{GT}}{2} > r^S$. This inequation is equivalent to $\frac{p^P r^{PT} + p^G r^{GT}}{2} > p^P r^S$. Notice that $[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi > 0$. As we are in the case, in which $p^P r^S < \frac{p^P r^{PT} + p^G r^{GT}}{2} < [p^P r^S]_2$, we cannot obtain $p^P r^S > [p^P r^S]_2$. Therefore, we only have a gambling equilibrium if $r^S < [r^S]_1$. However, the deviating bank can only choose r^S as long as its deposit volume is non-negative. Hence, the deviating bank cannot choose r^S if

$$\frac{1}{2} + \frac{p^P r^S - p^G r^{GT}}{2\pi} < 0$$

or equivalently if

$$r^S < \frac{p^G}{p^P} r^{GT} - \frac{\pi}{p^P}.$$

Notice that:

$$\frac{p^G}{p^P} r^{GT} - \frac{\pi}{p^P} < \frac{[p^P r^{PT} + p^G r^{GT}] + \sqrt{[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi}}{2p^P}.$$

Hence, $[r^S]_1$ is binding.

Finally, we have to check whether r_1^S or r^{GT} is binding. Note that r_1^S is binding if

$$r^{GT} > \frac{[p^P r^{PT} + p^G r^{GT}] - \sqrt{[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi}}{2p^P}.$$

This holds true if

$$2p^P r^{GT} > 2p^G r^{GT} > [p^P r^{PT} + p^G r^{GT}] - \sqrt{[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi}.$$

Since $2p^P r^{GT} > 2p^G r^{GT}$ is always fulfilled, this condition holds true:

$$2p^G r^{GT} > [p^P r^{PT} + p^G r^{GT}] - \sqrt{[p^P r^{PT} - p^G r^{GT}]^2 - 4 [p^G r^{GT} - p^P r^{PT}] \pi}.$$

This is fulfilled because

$$4 [p^P r^{PT} - p^G r^{GT}] \pi > 0.$$

Case 2 Finally, we may have $r^{GT} < r^S$. Then, a gambling equilibrium, where banks offer r^{GT} , cannot exist if the beliefs of the depositors are consistent in the equilibrium. In this case, banks will offer the lowest possible deposit rate, which is equal to r^S . Hence, the bank value in a potential gambling equilibrium is given by:

$$\hat{V}^G = \frac{1}{2} \delta p^G \left[\gamma^G - \frac{\theta}{\delta p^G} - r^S \right].$$

If the deviating bank offers a deposit rate, which leads depositors to believe that the bank is behaving prudently, we may have a gambling equilibrium in the case of:

$$\max_{r_j} \left[-\theta \left[\frac{1}{2} + \frac{p^P r_j - p^G r^S}{2\pi} \right] + \delta p^P [\gamma^P - r_j] \left[\frac{1}{2} + \frac{p^P r_j - p^G r^S}{2\pi} \right] \right] \leq \hat{V}^G.$$

The optimal deposit rate of the deviating bank fulfills:

$$-\theta \frac{p^P}{2\pi} + \delta p^P [\gamma^P - r_j] \frac{p^P}{2\pi} - \delta p^P \left[\frac{1}{2} + \frac{p^P r_j - p^G r^S}{2\pi} \right] = 0,$$

which can be rearranged to:

$$\delta p^P \left[\gamma^P - r_j - \frac{\theta}{\delta p^P} \right] p^P - \delta p^P [\pi + p^P r_j - p^G r^S] = 0$$

and

$$\gamma^P - r_j - \frac{\theta}{\delta p^P} - \frac{\pi}{p^P} - r_j + \frac{p^G}{p^P} r^S = 0.$$

Hence the optimal deposit rate of the deviating bank is given by:

$$\frac{r^{PT} + \frac{p^G}{p^P} r^S}{2} = r_j.$$

As before, we have to differentiate between $r_j < r^S$ and $r_j > r^S$. Assume that the first inequation holds. In this case, the deviating bank can offer r_j . Then a gambling equilibrium may exist if

$$\delta p^P \left[\gamma^P - \frac{r^{PT} + \frac{p^G}{p^P} r^S}{2} - \frac{\theta}{\delta p^P} \right] \left[\frac{1}{2} + \frac{p^P \frac{r^{PT} + \frac{p^G}{p^P} r^S}{2} - p^G r^S}{2\pi} \right] \leq \hat{V}^G.$$

Rearrangements lead to:

$$\frac{[p^P r^{PT} - p^G r^S]^2}{4\pi} \leq p^G r^{GT} - p^P r^{PT}.$$

The right side of the inequation is negative, whereas the left side of the inequation is positive. Consequently, we cannot have a gambling equilibrium. Assume, by contrast, $r_j > r^S$. In this

case, the deviating bank cannot offer r_j because this causes depositors to believe that the bank gambles. Thus the deviating bank offers the highest possible deposit rate, i.e. a deposit rate which is marginally smaller than r^S . If we approach the limit, i.e. the deviating bank chooses r^S , a gambling equilibrium exists if:

$$-\theta \left[\frac{1}{2} + \frac{p^P r^S - p^G r^S}{2\pi} \right] + \delta p^P [\gamma^P - r^S] \left[\frac{1}{2} + \frac{p^P r^S - p^G r^S}{2\pi} \right] \leq \widehat{V}^G.$$

This inequation is equivalent to:

$$\delta p^P \left[r^{PT} + \frac{\pi}{p^P} - r^S \right] \left[\frac{1}{2} + \frac{p^P r^S - p^G r^S}{2\pi} \right] \leq \delta p^G \left[r^{GT} + \frac{\pi}{p^G} - r^S \right] \frac{1}{2}.$$

Remember that we are in the case, in which

$$\frac{r^{PT} + \frac{p^G}{p^P} r^S}{2} > r^S$$

or equivalently

$$r^{PT} > 2r^S - \frac{p^G}{p^P} r^S.$$

Since $p^P > p^G$, we obtain $r^{PT} > r^S$. This means that $r^{PT} - r^S > 0$. Due to the fact that $\frac{p^P r^S - p^G r^S}{2\pi} > 0$, the inequation

$$\delta p^P \left[r^{PT} + \frac{\pi}{p^P} - r^S \right] \left[\frac{1}{2} + \frac{p^P r^S - p^G r^S}{2\pi} \right] \leq \delta p^G \left[r^{GT} + \frac{\pi}{p^G} - r^S \right] \frac{1}{2}$$

can only be fulfilled if $r^{GT} > r^S$. However, this is not the case, in which we are. Remember that we are in the case, in which $r^S > r^{GT}$.

To summarize, a gambling equilibrium does not exist if $r^S > r^{GT}$.

Prudent investment

As before, we differentiate between two cases:

1. $r^S > r^{PT}$
2. $r^S < r^{PT}$.

Case 1 Assume that the deviating bank chooses the gambling asset and a deposit rate which makes depositors believe that it gambles. From (2.19) in Section 2.5.1, we already know that the deviating bank offers $r_j = \frac{1}{2} \left[r^{GT} + \frac{p^P}{p^G} r^{PT} \right]$, which is only consistent with the depositors' beliefs if $r_j > r^S$. We have then the same result as in the transparent case. Hence, a prudent equilibrium always exists if $r_j > r^S$.

Of course, if a deviation is not beneficial where the deviating bank can choose its first-best deposit rate $r_j = \frac{1}{2} \left[r^{GT} + \frac{p^P}{p^G} r^{PT} \right]$, a deviation where the deviating bank chooses a second-best deposit rate, i.e. r^S , cannot be beneficial either.

To summarize, a prudent equilibrium always exists if $r^S > r^{PT}$.

Case 2 Assume $r^S < r^{PT}$, i.e. the banks cannot offer r^{PT} as it induces depositors to believe that they gamble. In a symmetric equilibrium, where banks offer a deposit rate, which causes depositors to believe that they are behaving prudently, the banks will then offer the highest possible deposit rate, i.e. r^S , and the bank value is equal to:

$$\widehat{V}^P = \frac{1}{2} \delta p^P \left[\gamma^P - \frac{\theta}{\delta p^P} - r^S \right].$$

Consider the maximization problem of the deviating bank. A unilateral deviation is not beneficial if

$$\max_{r_j} \left[-\theta \left[\frac{1}{2} + \frac{p^G r_j - p^P r^S}{2\pi} \right] + \delta p^G [\gamma^G - r_j] \left[\frac{1}{2} + \frac{p^G r_j - p^P r^S}{2\pi} \right] \right] \leq \widehat{V}^P,$$

where the optimal deposit rate of the deviating bank is equal to:

$$\frac{r^{GT} + \frac{p^P}{p^G} r^S}{2} = r_j.$$

We have to differentiate between $r_j < r^S$ and $r_j > r^S$. If $r_j < r^S$, r_j is not optimal as it leads depositors to believe that it behaves prudently. Hence, the deviating bank chooses the highest possible deposit rate which is equal to r^S . Then, a prudent equilibrium exists if

$$\delta p^G \left[r^{GT} + \frac{\pi}{p^G} - r^S \right] \left[\frac{1}{2} + \frac{p^G r^S - p^P r^S}{2\pi} \right] \leq \frac{1}{2} \delta p^P \left[r^{PT} + \frac{\pi}{p^P} - r^S \right].$$

Remember that we are in the case, in which $r_j < r^S$, i.e.

$$r^S > \frac{r^{GT} + \frac{p^P}{p^G} r^S}{2}$$

or equivalently

$$r^{GT} < 2r^S - \frac{p^P}{p^G} r^S.$$

Since $p^P > p^G$, we know that $r_j < r^S$ can only be fulfilled if $r^{GT} < r^S$. This, however, means that (remember that $r^S < r^{PT}$):

$$\delta p^G \left[r^{GT} + \frac{\pi}{p^G} - r^S \right] < \delta p^P \left[r^{PT} + \frac{\pi}{p^P} - r^S \right].$$

Due to the fact that $p^G r^S < p^P r^S$, the inequation

$$\delta p^G \left[r^{GT} + \frac{\pi}{p^G} - r^S \right] \left[\frac{1}{2} + \frac{p^G r^S - p^P r^S}{2\pi} \right] \leq \frac{1}{2} \delta p^P \left[r^{PT} + \frac{\pi}{p^P} - r^S \right]$$

cannot be fulfilled. Therefore, we obtain a prudent equilibrium if $r_j < r^S$.

By contrast, if $r_j > r^S$, the deviating bank can offer r_j . A deviation is, nevertheless, not beneficial if

$$\delta p^G \left[\gamma^G - \frac{r^{GT} + \frac{p^P}{p^G} r^S}{2} - \frac{\theta}{\delta p^G} \right] \left[\frac{1}{2} + \frac{p^G \frac{r^{GT} + \frac{p^P}{p^G} r^S}{2} - p^P r^S}{2\pi} \right] \leq \widehat{V}^P.$$

Rearrangements lead to:

$$\left[p^G r^{GT} - p^P r^S \right]^2 \leq 4\pi \left[p^P r^{PT} - p^G r^{GT} \right].$$

The solution of the corresponding equation is given by:

$$\left[p^P r^S \right]_{1/2} = p^G r^{GT} \pm 2\sqrt{\pi \left[p^P r^{PT} - p^G r^{GT} \right]}.$$

Hence, the solution is:

$$\begin{aligned} \left[p^P r^S \right]_1 &= p^G r^{GT} - 2\sqrt{\pi \left[p^P r^{PT} - p^G r^{GT} \right]} \\ &< \left[p^P r^S \right] < \left[p^P r^S \right]_2 = p^G r^{GT} + 2\sqrt{\pi \left[p^P r^{PT} - p^G r^{GT} \right]}. \end{aligned}$$

Notice that $D \geq 0$ has to be fulfilled. Therefore, we must have:

$$\left[\frac{1}{2} + \frac{p^G r^{GT} - p^P r^S}{4\pi} \right] \geq 0$$

or, equivalently,

$$p^P r^S \leq p^G r^{GT} + 2\pi.$$

We have

$$p^G r^{GT} + 2\pi < p^G r^{GT} + 2\sqrt{\pi \left[p^P r^{PT} - p^G r^{GT} \right]},$$

which is equivalent to:

$$\pi^2 < \pi \left[p^P r^{PT} - p^G r^{GT} \right],$$

if

$$0 < \pi < p^P r^{PT} - p^G r^{GT}.$$

Notice that $p^P r^S \leq p^G r^{GT} + 2\pi$ is the same condition which has to be fulfilled in order to guarantee a non-negative expected net return.

To summarize, a prudent equilibrium exists if

$$r^S < r^{PT}$$

and

$$r^S > \frac{r^{GT} + \frac{p^P}{p^G} r^S}{2},$$

which is equivalent to:

$$r^S > \frac{p^G r^{GT}}{2p^G - p^P},$$

or

$$r^S < \frac{p^G r^{GT}}{2p^G - p^P}$$

and

$$\begin{aligned} [p^P r^S]_1 &= p^G r^{GT} - 2\sqrt{\pi [p^P r^{PT} - p^G r^{GT}]} \\ &< [p^P r^S] < [p^P r^S]_2 = p^G r^{GT} + 2\sqrt{\pi [p^P r^{PT} - p^G r^{GT}]}. \end{aligned}$$

These conditions for a prudent equilibrium (case 1 and 2) can be simplified. Notice that only $[p^P r^S]_1$ is binding if $p^P r^{PT} < [p^P r^S]_2$ (remember that $p^P r^{PT} > p^G r^{GT}$, i.e. we cannot have $p^P r^{PT} < [p^P r^S]_1$). This holds true because we also have a prudent equilibrium if $p^P r^S > p^P r^{PT}$. Therefore, $[p^P r^S]_2$ may only be binding if $p^P r^{PT} > [p^P r^S]_2$. This inequation is fulfilled if

$$\frac{p^P r^{PT} - p^G r^{GT}}{4} > \pi.$$

However, if this inequation is fulfilled, we know that $p^G r^{GT} + 2\pi < p^G r^{GT} + 2\sqrt{\pi [p^P r^{PT} - p^G r^{GT}]}$, i.e. the condition for a non-negative deposit volume of the deviating bank ($p^P r^S \leq p^G r^{GT} + 2\pi$) is binding. As a deviation is never beneficial if the deposit volume is negative, the condition $p^P r^S \leq p^G r^{GT} + 2\pi$ does not have to be indicated explicitly. Therefore, the only binding condition is $[p^P r^S]_1$. Hence, we have a prudent equilibrium if

$$r^S > \frac{p^G r^{GT} - 2\sqrt{\pi [p^P r^{PT} - p^G r^{GT}]}}{p^P}.$$

Chapter 3

Contingent Public Bailout, Contagion and Bank Risk-Taking

3.1 Introduction

During the recent financial crisis, the bailout of some major banks was perceived as necessary to prevent a break-down of the financial system. Although bailouts might be able to avoid a spill-over to sound banks, it is often argued that they create moral hazard. The economic theory provides diverging predictions with regard to the impact of bank bailouts on the risk-taking of banks. On the one hand, the announcement of bailouts can be considered to be implicit government protection against failure in the future. This may encourage banks to increase their risk-taking (Hakenes & Schnabel (2010); Dam & Koetter (2012)). On the other hand, bailouts increase the charter value of banks, which prevents them from investing in risky assets (Keeley (1990)). Cordella & Yeyati (2003) take both effects into account and show that ex ante announced bank bailouts in times of macroeconomic distortions can reduce a bank's risk-taking because the value effect outweighs the moral-hazard-effect.

This result depends on several assumptions which will be challenged in this chapter. First, the "macroeconomic environment" must be a factor that is outside the banks' sphere of influence but which affects their probability of success. Otherwise these banks may attempt to bring about such conditions in order to be secured by the regulator (Acharya & Yorulmazer (2007); Farhi & Tirole (2012)). Second, in order to be able to rescue them "prudentially", authorities must have perfect information about the impact of the macroeconomic conditions on the banks' business. Third, Cordella & Yeyati (2003) consider a monopoly bank and neglect the impact of competition on the banks' investment decision. Fourth, they do not differentiate between globally systemic institutions and local banks, which are less important for the stability of the financial system. Hence, each bank should be rescued in times of macroeconomic distortions. Macroeconomic conditions may play a role when deciding whether to rescue or to liquidate a bank. However, a bank's impact on the stability of the financial system is also

a crucial factor for the authorities.¹ We take this into account in the second part of this paper, where the interconnectedness of the banks plays an important role for the stability of the financial system.²

To address these issues, we use a similar framework as Repullo (2004). In contrast to Chapter 2, we use a dynamic model, endogenize the banks' charter value and model competition à la Salop (1979), i.e. banks are located on the circumference of a circle instead of a straight line. This enables us to study both the impact of bank competition and the interconnectedness (systemic relevance) of banks on the linkage between bank bailouts and the risk-taking of banks. Similarly to the previous chapter, banks compete in the deposit markets and invest their funds in either a prudent or a gambling asset. The probability of their project success depends on the asset type and on a state of nature (i.e. macroeconomic conditions). We assume that this state of nature can be observed and verified by a third party, which enables the regulator and the banks to sign a contract on a certain bailout policy (complete-contract approach). Consequently, the regulator is able to announce a credible bailout policy *ex ante*. After the announcement, the banks offer deposit rates and invest their funds. In contrast to the offered deposit rates and the investment decisions, the bailout policy is announced once for the entire game. The investment decision is private information and cannot be observed by the regulator, except in the basic scenario. We focus on strategy combinations in equilibrium which form equilibria at every stage of the game. To solve the game, we apply backward induction.

These assumptions lead to the following results: Under symmetric information, the regulator can differentiate between prudent and gambling banks, and the optimal bailout policy suggests liquidating gambling and rescuing prudent banks with probability one, i.e. always. Asymmetric information forecloses the possibility of differentiating between sound (prudent) and unsound (gambling) banks. In this case, the regulator should bail out insolvent banks with probability one in times of macroeconomic distortions and liquidate them with probability one otherwise. Such a bailout policy does not alter banks' investment behaviour if the banking market is too competitive. The intuition is the following: A higher bailout probability increases the banks' charter value independently of whether it invests in a gambling or a prudent asset. If the regulator rescues banks in rather instable times and liquidates them in rather stable times, the relative charter value from investment in prudent assets increases and thus raises opportunity costs of the gambling asset. In highly competitive banking markets, the banks' charter value is too low, so that an increase of this charter in the course of a well-suited bailout policy is not sufficient to induce prudential behaviour. This also has the consequence of negative effects of an ill-suited bailout policy. Such a policy does not cause gambling behaviour if the banking market is sufficiently competitive.

¹In Germany, for instance, Commerzbank and Hypo Real Estate were rescued due to their importance for the financial stability, at least in Germany.

²We do not postpone the analysis presented in this section to Chapter 4 because in that chapter we restrict our attention on two-stage games which do not allow for the internalization of the banks' charter value.

If the regulator conditions his bailout policy on the basis of macroeconomic situations which do not influence banks' probability of success to a sufficiently large extent, he increases moral hazard. We model this by assuming that the regulator receives a signal about the true impact of the banks' environment on their probability of success. Then the regulator should rescue only if he receives a sufficiently reliable signal about whether the failure arises from bad luck or from risky investments. To say it in a different way, the regulator should rescue only if he is certain about the impact of these conditions on the banks' probability of success.

Alternatively, he can condition his bailout policy on the systemic relevance of banks. Therefore, we assume that the failure of a bank causes contagion resulting in the failure of neighbouring banks with a pre-defined probability. Although banks may be able to influence the contagion probability, we argue that this takes time. Consequently, at least in the short and medium term, the banks' systemic relevance may be constant. We find that a regulator who rescues banks, whose systemic relevance is not too high, decreases moral hazard, even if his policy is too accommodative with regard to the policy based only upon macroeconomic factors. The critical threshold increases with the number of banks, so that even systemic banks which cause contagion with a rather high probability should be rescued.

The bailout of an insolvent bank is not in the focus of the current draft version of the Bank Recovery and Resolution Directive (BRRD). This chapter illustrates some stabilizing effects of a bailout and argues that regulators should not deny such a measure categorically. The bail-in tool preferred in the BRRD ensures that taxpayers do not have to bear all the costs of a failure. This may be a step in the right direction. However, since such a policy has not yet been tested, and, therefore, may fail in emergency, bank bailouts should not be demonized, but considered, at least, as a "tool of last resort".

This chapter proceeds as follows: Section 3.2 provides an overview of the related literature. Section 3.3 introduces the model, and Section 3.4 derives the optimal bailout policy under symmetric and asymmetric information when the regulator conditions his bailout policy on macroeconomic indicators. In Section 3.5, we determine the optimal bailout policy of a regulator who conditions his bailout policy on the systemic relevance of banks. Section 3.6 concludes Chapter 3.

3.2 Literature review

Two strands in the literature are related to our model. One strand analyses the impact of private and public bank bailouts on the behaviour of banks. A second strand deals with the impact of bank competition on the risk behaviour of banks.

Perotti & Suarez (2002) argue that private bailouts, i.e. bailouts by solvent banks, are more efficient than public bailouts because the charter value of acquiring banks is increased, which induces them *ex ante* to behave more prudently. Acharya & Yorulmazer (2007) show that the private solution is efficient if the number of insolvent banks is sufficiently small. This results from the fact that a bailout policy which depends on the banks' interconnectedness

induces them to increase it. To avoid this, the regulator should rely on solvent banks acquiring insolvent institutions. If the number of insolvent banks becomes sufficiently high, there will not be enough solvent banks that are able to afford an acquisition. As a consequence, failed banks have to be sold to investors outside the banking sector, which leads to welfare losses since these investors do not have the same skills. In this case, the regulator should assist solvent banks so that acquisitions become affordable (Acharya & Yorulmazer (2008)).³ If private bailouts are not feasible, a public bailout may be desirable, as liquidation is costly, too. According to Freixas (1999), an insolvent bank should be bailed out with probability one if rescue costs are sufficiently lower than liquidation costs. Otherwise, the regulator should not liquidate with probability one, but implement "ambiguity" and rescue with a probability between zero and one. Gorton & Huang (2004) argue that even if private bailouts are feasible, government bailouts may be desirable, since privately supplied liquidity is costly for society. We restrict our attention to public bank bailouts and do not ask whether private or public bailouts are more desirable (Gorton & Huang (2004)). While the size of the bank is not the key ingredient (Freixas (1999)), the interconnectedness between banks plays an important role, as described by Acharya & Yorulmazer (2007) and Acharya & Yorulmazer (2008).

Moreover, even if costs are not taken into account, properly designed bailouts can be desirable. Nagarajan & Sealey (1995) and Cordella & Yeyati (2003) find that such a bailout policy should be contingent on the bank's macroeconomic environment. Assuming that the regulator can credibly commit to his bailout policy, Cordella & Yeyati (2003) find that a properly designed policy can decrease a bank's portfolio risk and thus reduce moral hazard. The reason is that a higher bailout probability increases a bank's charter value, which induces it to behave more prudently (value effect). However, a higher bailout probability also decreases the influence of the bank's choice of risk on its probability of surviving (moral-hazard-effect). The value effect outweighs the moral-hazard-effect in the case of adverse macroeconomic conditions. Similarly, Keeley (1990), Suarez (1994), Hellmann et al. (2000) and Repullo (2004) find that the charter value causes banks to behave more prudently. Mailath & Mester (1994) show that when regulators cannot credibly commit themselves to future actions, but monitor banks perfectly, the closure of a bank may reduce welfare, independently of whether the regulator cares about the costs of a bank closure and the net return of the projects funded by the bank or only about the costs of a closure and depositor payouts costs. Hakenes & Schnabel (2010) find that guarantees for unsecured depositors may have a risk-reducing-effect of the protected bank, but they increase the risk-taking of the competitor bank.

According to Dell'Ariccia & Ratnovski (2011), bank bailouts can reduce moral hazard if the regulator can credibly commit himself to a bailout policy which promises the bailout of systemic banks. Similarly to Cordella & Yeyati (2003), they show that bank bailouts have two effects. On the one hand, a higher bailout probability gives a failing bank some rent if it is assumed to cause contagion, which leads to higher risk-taking. On the other hand, it protects

³By contrast to Cordella & Yeyati (2003), Acharya & Yorulmazer (2007) do not consider an exogenous solvency shock, but assume that banks enforce the occurrence of crisis by investing in similar projects.

banks from being hit by a failing neighbour-bank, which increases expected profit and thus induces banks to behave more prudently. When systemic banks are rescued, the latter effect dominates. Consequently, the regulator should rescue them with probability one. Although we also examine the relation between bank bailouts, interconnectedness of banks and bank risk-taking, we do not restrict our attention to this. We also ask how bank bailouts affect the risk-taking behaviour of banks which are not interconnected. Similarly to Cordella & Yeyati (2003), we take the macroeconomic environment into account. In contrast to Cordella & Yeyati (2003), we examine how the bailout policy should be designed if the regulator cannot perfectly condition on macroeconomic situations and allow for competition among banks. While Dell'Ariccia & Ratnovski (2011) choose a static framework, we analyse the effects of the bailout policy in a dynamic setup. Consequently, we are able to endogenize the banks' charter value. As in Keeley (1990), Suarez (1994), Hellmann et al. (2000) and Repullo (2004), the charter value plays a key role. Repullo (2004) shows that minimum capital requirements can decrease banks' risk-taking incentives as they lower deposit rates in equilibrium, which increases the banks' margin.

Apart from the regulator's bailout policy, the risk-taking of banks is also influenced by competition on the deposit and the loan market. Boyd & De Nicoló (2005) find that higher competition can prevent banks from investing in particularly risky projects. On the one hand, higher competition in the deposit market increases deposit rates and decreases expected profits, which raises banks' incentives to invest in riskier projects. On the other hand, competition decreases the loan rates of corporates, which increases their incentives to stay solvent (risk-shift effect). A lower loan rate, in turn, decreases the banks' margin and therefore increases the incentives to gamble (margin effect). According to Martinez-Miera & Repullo (2010), the risk-shifting effect dominates in monopolistic markets, whereas the margin effect dominates in competitive markets. De Nicoló & Lucchetta (2011) provide evidence that imperfect competition might be optimal from a welfare point of view if information technology features constant returns to scale, while in the case of increasing returns to scale perfect competition is desirable. In contrast to Boyd & De Nicoló (2005) and Martinez-Miera & Repullo (2010), we only account for competition in the deposit market.

As in this model, some papers also use the Salop model and analyse the relation between competition and bank risk-taking. Matutes & Vives (1996) assert that the fragility of financial institutions is due to depositors' differentiated expectations. If depositors perceive a bank to be safe, the bank receives a higher margin and thus decreases its risk level. Consequently, the probability of failure results from the self-fulfilling expectation of depositors. Hellmann et al. (2000) and Repullo (2004) suggest higher capital reserves in order to induce prudent behaviour.⁴ As in this chapter, they model competition among banks à la Salop and focus on competition on the deposit market. Repullo (2004) is closest to the model presented in this

⁴See also Bolt & Tieman (2004). However, Hellmann et al. (2000) assert that capital controls are not sufficient to achieve a Pareto efficient outcome and deposit rate controls are necessary. Gale (2010) argues that capital controls can increase investment risk if banks try to maximize rates of return.

chapter. However, while he focuses on the relation between minimum capital requirements on banks' risk-taking behaviour without taking bank bailouts into account, we restrict our attention to the effects of bank bailouts on the risk-taking behaviour of banks.

3.3 The model

3.3.1 Players and action sets

This model extends the findings of Repullo (2004) by introducing a regulator who can bail out insolvent banks. We consider the following groups of risk-neutral players: shareholders who run $n > 2$ banks (henceforth, we often write "banks"), secured depositors, and a regulator who decides about the bailout policy. Each generation of depositors and shareholders lives for one period, does not have alternative investment possibilities and desires to consume at the end of its life, i.e. at the end of the investment period. This means that at the end of each investment period, the payoffs are distributed to the depositors and the shareholders and a new investment period begins, unless the bank is liquidated.

Banks

The banks are symmetrically located on a circumference of length one. As in the previous chapter, shareholders invest an infinitesimal amount of equity into the banks. In contrast to the previous chapter, the investment takes place at the beginning of each period. Additionally, at the beginning of each investment period (discrete time), each bank $j = 1, \dots, n$ chooses the deposit rate r_j and either invests in a prudent asset or in a gambling asset. The prudent investment is indexed with " P " and the gambling investment is indexed with " G ". The investment decision is private information to the banks, except in Section 3.4.1. Hence, the balance sheet total consists of the infinitesimal amount of equity and deposits.

The prudent investment yields a rate of return (henceforth, we often write return) $\gamma^P \in (0, 1)$ with probability p^P and a return of zero otherwise. The gambling investment generates a return $\gamma^G \in (0, 1)$ with probability p^G and a return of zero otherwise.

The probability of project success depends on the asset type, P or G , and on an exogenous state of nature which can be either "good" (economic boom) or "bad" (economic downturn or even a crisis) for the banks. This state of nature represents the macroeconomic conditions which influence the success of the projects. If these macroeconomic conditions are in favour of the banks (good), the probability of project success is predominantly determined by the banks' asset choice. By contrast, if these conditions are bad, the probability of success is, to a relatively low extent, influenced by the banks' choice. We denote the probability that the good state H appears with probability q and that the bad state L appears with probability $1 - q$. Notice that the banks' investment decision does not have an impact on the macroeconomic condition.

In order to connect these macroeconomic conditions with the banks' probability of success, we assume that in the good case H , the probability that banks are hit by a shock is low. This probability is denoted with $1 - v^{boom}$ (the index "boom" stands for good macroeconomic conditions). Hence, in the good state, banks are not hit by a shock with probability v^{boom} . By contrast, in the bad case L , this probability is high and denoted with $1 - v^{bust}$ (the index "bust" stands for bad macroeconomic conditions), where $v^{boom} > v^{bust}$. If the shock occurs, the project return is zero, independent of whether a bank chose the prudent or the gambling investment. Hence, the return can be zero due to the solvency shock and/or due to project failure. The insertion of v and q allows one to differentiate between the two reasons for the failure of a bank: failure of the project or bad circumstances. Notice that the banks' investment decision does not have an impact of the probability that a shock occurs.

Following these assumptions, we can summarize the return functions R^G and R^P :

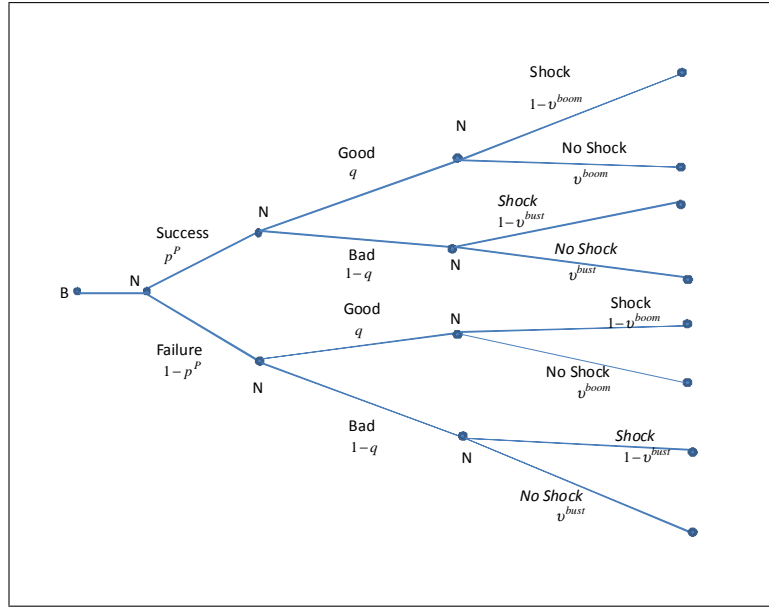
$$\begin{aligned} R^G &= \begin{cases} \gamma^G & \text{with probability } p^G [qv^{boom} + [1 - q] v^{bust}] \\ 0 & \text{with probability } 1 - p^G [qv^{boom} + [1 - q] v^{bust}] \end{cases} \\ R^P &= \begin{cases} \gamma^P & \text{with probability } p^P [qv^{boom} + [1 - q] v^{bust}] \\ 0 & \text{with probability } 1 - p^P [qv^{boom} + [1 - q] v^{bust}] \end{cases} . \end{aligned}$$

For example, assume that the macroeconomic conditions are good ($q = 1$) and $v^{boom} = 1$. Then the probability of project success is solely determined by the banks' asset choice. By contrast, if the conditions are bad ($q = 0$) and v^{bust} is very low, let us say close to zero, the probability of success is very low, even if the bank chooses the prudent asset. Since the bank does not know the true state of nature ex ante (when the investment decision is taken), the probability of success depends on the expected conditions. The return of the gambling asset is supposed to be higher than the return of the prudent asset, $\gamma^G > \gamma^P$, but the expected return is lower, i.e. $p^P \gamma^P > p^G \gamma^G$. Limited liability of banks provides incentives to invest in the gambling asset and thus induces moral hazard.

In order to get more familiar with the different probabilities, consider Figure 3.1. This figure illustrates the "decision tree" for an isolated bank which can and will only choose the prudent asset. The node, denoted with B , is the "decision node" of the isolated bank, and the nodes, denoted with N , are the "decision nodes" of the nature. The figure also indicates the probabilities for the paths. Remember that the bank only obtains a positive return if the project is successful and no shock occurs. As a consequence, the probability that the bank receives the return γ^P is $p^P [qv^{boom} + (1 - q) v^{bust}]$.

The residual of the project payoff (after depositors have been paid) is distributed among the banks' shareholders. We further assume that shareholders have a time preference which is represented by the discount factor $\delta > 0$.

Figure 3.1: "Decision tree" of an isolated and prudent bank



Depositors

Deposits are secured by a deposit insurance. The aggregate market volume of deposits is constant to one. To derive the deposit demand function, we use a modification of the Salop model. The depositors are continuously distributed on the circumference. Depositing funds in a bank induces "transportation costs per unit of distance", $\pi > 0$, which can be interpreted as a heterogeneity factor for banks. Imagine, for instance, that interest rates on secured deposits are not the only feature a customer takes into account when depositing his funds in a bank. Advisory services or/and the location of cashpoints might also play a role for his decision. Following the cashpoint argument, we can assume that potential depositors are located between two cashpoints, owned by different banks, and they choose the bank with the nearest one.

The amount of creditors which bank j attracts depends on its offered deposit rate, on the deposit rate offered by its neighbours $j + 1$ (to the right) and $j - 1$ (to the left) and on the transportation costs π . We denote the deposit rate, offered by bank j , with $r_j \in (0, 1)$ and the deposit rates, offered by the neighbour banks, $j + 1$ and $j - 1$, by r_{j+1} and r_{j-1} . A depositor located between bank j and bank $j + 1$ is indifferent towards these banks if his net returns are the same, thus if

$$r_j - \pi z = r_{j+1} - \pi \left[\frac{1}{n} - z \right]$$

holds,⁵ where z is the distance between the indifferent depositor and bank j (or its cashpoint)

⁵In contrast to Chapter 2, the distance between bank $j + 1$ (i.e. $-j$) and the indifferent depositor is now given by $\frac{1}{n} - z$ instead of $1 - z$.

and $\frac{1}{n} - z$ the distance between the indifferent depositor and bank $j + 1$.⁶ Solving for z reveals the "amount" of depositors on the line between bank j and $j + 1$, who decide to deposit their funds in bank j :

$$z(r_j, r_{j+1}) = \frac{1}{2n} + \frac{r_j - r_{j+1}}{2\pi}.$$

Due to the symmetrical order, the distance between bank j and $j + 1$ is equal to the distance between bank j and $j - 1$. As a result, the total demand of depositors who lend their funds to bank j , amounts to:⁷

$$D_j(r_j, r_{j-1}, r_{j+1}) = \frac{1}{n} + \frac{2r_j - r_{j+1} - r_{j-1}}{2\pi}, \quad (3.1)$$

where $D_j(r_j, r_{j-1}, r_{j+1}) \geq 0$ has to be fulfilled (a negative amount of depositors is impossible). The demand of deposits, D_j , decreases in n , r_{j+1} and r_{j-1} and increases in r_j . The more the banks are heterogenous, i.e. the higher the distance between the cashpoints (higher π), the lower the impact of deposit rates on deposit demand. The aggregate demand of deposits is constant and normalized to one. As we only consider symmetric equilibria, we can henceforth write $2r_{-j}$ instead of $r_{j+1} + r_{j-1}$.

Finally, we normalize the deposit insurance premium to zero.

Regulator

The regulator prefers prudent investments over gambling investments of the banks. Therefore, his payoff function is quite simple, as he is only interested in the investment decision of the banks.

We assume that the state of nature is observable and verifiable by a third party (complete-contract approach). Hence, the regulator and the bank can sign a contract which promises a bailout in the case of pre-defined circumstances (states of nature). Therefore, the regulator can announce a credible bailout policy *ex ante*. The bailout policy then remains constant over time. We allow for bailout probabilities $0 \leq \beta \leq 1$ which might be ensured by institutional arrangements making it unclear (i.e. ambiguous) for the banks whether the regulator intervenes or not (Dell'Ariccia & Ratnovski (2011)).

If a bank is insolvent at the end of an investment period, which is equivalent to the fact that its project was not successful, the regulator bails it out with probability β^H if the macroeconomic conditions are good. If the macroeconomic conditions are bad, the regulator bails a failed bank out with probability β^L . Hence, the regulator conditions his bailout policy on the macroeconomic condition. For the time being, the regulator has perfect information about the impact of the macroeconomic conditions on the banks' probability of success. For

⁶Notice that the comparison between transportation costs and returns is possible because of the normalization of payoffs and returns.

⁷Notice that the demand of deposits does not depend on the banks' investment risk because deposits are covered by a deposit insurance.

example, if these conditions are good, $q = 1$, the regulator knows that the banks' projects will fail with probability $1 - v^{boom}$.

Bailout means that depositors are paid by the regulator and the bank can continue to operate in the following period. Liquidation means that the bank is closed and replaced by another bank. Hence, if a bank is liquidated, it loses potential charter value.

Following these assumptions, the probability s of surviving in P is given by:

$$s^P = q [p^P v^{boom} + [1 - p^P v^{boom}] \beta^H] + [1 - q] [p^P v^{bust} + [1 - p^P v^{bust}] \beta^L] \quad (3.2)$$

and in G by:

$$s^G = q [p^G v^{boom} + [1 - p^G v^{boom}] \beta^H] + [1 - q] [p^G v^{bust} + [1 - p^G v^{bust}] \beta^L]. \quad (3.3)$$

For example, if $q = 1$, i.e. the macroeconomic conditions are good and therefore a bank survives if

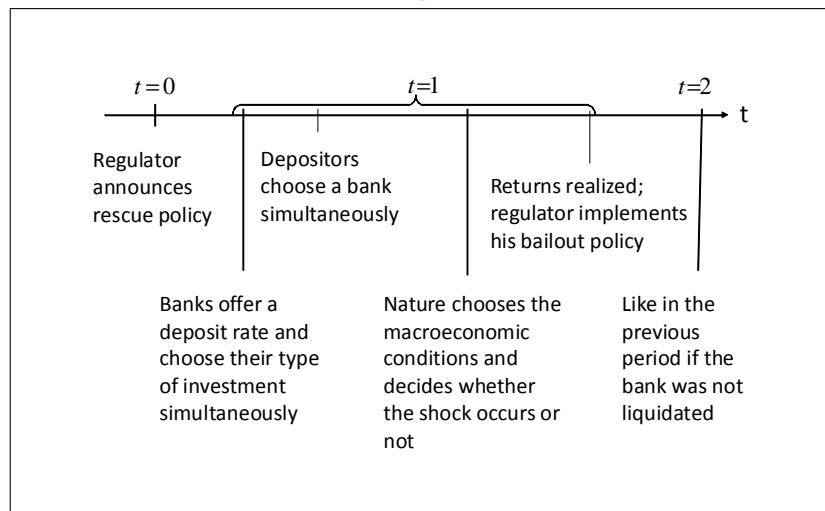
- its project is successful and it is not hit by the shock, i.e. with probability $p^P v^{boom}$ in the prudent case and with probability $p^G v^{boom}$ in the gambling case, or
- its project is not successful, but it is rescued by the regulator, i.e. with probability $[1 - p^P v^{boom}] \beta^H$ in the prudent and with probability $[1 - p^G v^{boom}] \beta^H$ in the gambling case.

In the symmetric information case, the regulator can also differentiate between the project type, whereas in the asymmetric information case, the regulator has to apply the same bailout probability for prudent and gambling banks.

3.3.2 Sequence of events

The time structure of the model is illustrated in Figure 3.2. At the beginning of an initial period, the regulator announces and can credibly commit himself to a bailout policy that is contingent on the state of nature v and applied in all of the following periods. Then each bank offers a deposit rate and decides about the type of investment, i.e. prudent or gambling. Thereafter, depositors decide where to store their funds. If the project is successful, shareholders and depositors share the payoff and the bank can continue to operate in the second period where it collects funds again from shareholders and depositors. If the project fails, the regulator either rescues or liquidates the bank in accordance with his announced bailout policy. A rescued bank can continue to operate and invest again in the following period. A liquidated bank is always replaced by another bank so that the number of banks remains constant. This sequence is repeated in each period t .

Figure 3.2: Sequence of events



3.3.3 Equilibrium concept

The presented game is a repeated game. In such a game, various equilibria may exist. Banks could, for instance, base their decisions on past decisions taken by neighbouring banks. Moreover, we might have an equilibrium, where banks are able to coordinate over time in such a way that they receive all the surplus. In this game, we do not consider such possibilities. We rather assume that the players cannot know or/and do not care about the past. Hence, after the payoffs have been realized at the end of an investment period, the players forget the decisions they made in the past and the decisions made by the other players. Consequently, we have a "repeated game".

In order to simplify this, we restrict our attention to strategy combinations, which form an equilibrium at each stage of the game. We look at a representative stage of the game and determine the equilibria at this stage. Markov strategies lead to such equilibria because they only depend on state variables which summarize the impact of the past on the current play (Fudenberg & Tirole (1995)). In our case, the state variable I_t represents whether the bank is left open or is closed at the beginning of period t . Tomorrow's state, i.e. I_{t+1} , depends on the banks' actions in period t and on the regulator's bailout decision. Consequently, the past only matters in such a way that if the bank is still open, i.e. has survived, it can invest again. If the bank has been liquidated, it cannot invest any more.

We focus on two types of symmetric equilibria at the representative stage t : a prudent equilibrium, where all banks choose the deposit rate r^P and the prudent asset P , and a gambling equilibrium where all banks choose the deposit rate r^G and the gambling asset G . In the prudent equilibrium, bank j does not have an incentive to choose a deposit rate $r \neq r^P$ and G in period t and r^P and P in periods $t+1, \dots, \infty$, while all other banks $-j$ choose r^P and P in periods t, \dots, ∞ and depositors do not have an incentive to change the bank. Equivalent conditions hold in the gambling equilibrium.

In the representative period t , we can solve the game by applying backward induction. We begin with the third stage where depositors choose their bank. Taking this decision into account, banks decide at the second stage in which asset they invest and which deposit rate they offer. This decision is taken simultaneously, i.e. the banks cannot observe the decision of their neighbours. At the first stage, the regulator announces the bailout policy.

The bailout policy, which is always a best strategy, that is, independent of the competition parameters π and n , is called the "optimal" bailout strategy. Of course, in many cases where the bailout policy does not have an impact on the banks' investment decision, this optimal bailout policy is not the only strategy in an equilibrium.

3.4 Public bank bailouts contingent on the macro-economic environment

3.4.1 Symmetric information on investment decisions

In this basic scenario, the banks' investment decision is supposed to be public information and verifiable by a third party. Therefore, the regulator and the banks can sign a contract which promises a bailout, depending on the investment decision. Consequently, the regulator can credibly announce such a bailout policy ex ante. We denote the bailout probability for banks investing in prudent assets by β_P^H and β_P^L and the bailout probability for gambling banks by β_G^H and β_G^L . Following these assumptions, the probability \tilde{s}^P of surviving in P is given by:

$$\tilde{s}^P = q [p^P v^{boom} + [1 - p^P v^{boom}] \beta_P^H] + [1 - q] [p^P v^{bust} + [1 - p^P v^{bust}] \beta_P^L]$$

and in G by:

$$\tilde{s}^G = q [p^G v^{boom} + [1 - p^G v^{boom}] \beta_G^H] + [1 - q] [p^G v^{bust} + [1 - p^G v^{bust}] \beta_G^L].$$

At the beginning of each period, bank j chooses the deposit rate r_j and the investment type $\gamma \in \{\gamma^P, \gamma^G\}$ in order to maximize its value V_j , i.e. the net present value of expected period profits. The game is solved by backward induction starting with the equilibrium deposit rate and investment decision in period t . Thereafter, we determine the optimal bailout policy.

In a prudent equilibrium, bank j does not have an incentive to deviate unilaterally in period t by choosing the gambling asset (the others behave prudently) and the corresponding deposit rate which maximizes the net expected value of investment in period t . Equivalently, in the gambling equilibrium, no bank has an incentive to deviate unilaterally in period t by choosing the prudent asset and the corresponding deposit rate which maximizes the net expected value of investment in period t . Therefore, we have to determine the payoff of the banks which choose the gambling asset and the corresponding deposit rate in each period t as well as the payoff of banks which choose the prudent asset in each period. Moreover, we have to

determine the payoff of a deviating bank.

To begin with, assume that bank j chooses the prudent investment at stage one. Then its optimization problem is given by:

$$\max_{r_j} \left[\delta \Pi_j^P(r_j, r_{-j}) + \delta \tilde{s}^P \tilde{V}_j^P \right], \quad (3.4)$$

where $\Pi_j^P(r_j, r_{-j})$ is the expected period profit defined by:

$$\Pi_j^P(r_j, r_{-j}) = p^P [qv^{boom} + [1 - q]v^{bust}] [\gamma^P - r_j] D_j^P(r_j, r_{-j}). \quad (3.5)$$

$\gamma^P - r_j$ is the net payoff on deposits. Notice that $\gamma_j - r_j$ is equal to $(1 + \gamma^P) - (1 + r_j)$, i.e. gross return minus gross debt. Equivalently, the expected net period profit is the difference between gross expected payoff of investment $p^P [qv^{boom} + [1 - q]v^{bust}] (1 + \gamma^P) D_j^P(r_j, r_{-j})$ and gross expected liabilities $p^P [qv^{boom} + [1 - q]v^{bust}] (1 + r_j) D_j^P(r_j, r_{-j})$.

After solving the maximization problem in (3.4), we obtain the equilibrium deposit rate:

$$r^P := \gamma^P - \frac{\pi}{n}. \quad (3.6)$$

Obviously, r^P increases in γ^P and n and decreases in π .⁸ Not surprisingly, depositors receive the gross project return γ^P less the "transportation costs". This results from the fact that banks compete in price, thus we have imperfect Bertrand competition where the "firms" do not receive a payoff beyond their costs. Banks only receive the costs of capital and a surplus $\frac{\pi}{n}$. Substituting $r^P = r_j$ in the objective function (3.4), and taking into account the fact that the maximized value is also \tilde{V}^P , the optimal bank value in the prudent is given by:

$$\tilde{V}^P = \frac{\delta p^P [qv^{boom} + [1 - q]v^{bust}]}{1 - \delta \tilde{s}^P} \frac{\pi}{n^2}. \quad (3.7)$$

\tilde{V}^P increases in π and decreases in the number of banks n , the market power for each bank. This is due to the fact that higher competition leads to higher returns on deposits (3.6) and thus to lower expected profits. Therefore, the opportunity costs of the gambling investment decrease. Perfect competition, $n \rightarrow \infty$, increases the deposit rates in such a way that the bank value converges to zero.

Equivalently, the equilibrium deposit rate in case of the gambling investment amounts to:

$$r^G := \gamma^G - \frac{\pi}{n} \quad (3.8)$$

which leads to the bank value

$$\tilde{V}^G = \frac{\delta p^G [qv^{boom} + [1 - q]v^{bust}]}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2}. \quad (3.9)$$

⁸ Apart from a decrease in deposit rates, higher competition, thus a higher number of banks, might reduce loan rates, too (Hauswald & Marquez (2006)).

In a prudent equilibrium bank j does not have an incentive to deviate unilaterally in period t by choosing the gambling asset (the others behave prudently) and the corresponding deposit rate, which maximizes the net expected value of investment in period t , i.e.:

$$\max_{r_j} \left[\delta \Pi_j^G(r_j, r_{-j}^P) + \delta \tilde{s}^G \tilde{V}^P \right] \leq \tilde{V}^P.$$

In the gambling equilibrium, no bank has an incentive to deviate unilaterally in period t by choosing the prudent asset and the corresponding deposit rate, which maximizes the net expected value of investment in period t , i.e.:

$$\max_{r_j} \left[\delta \Pi_j^P(r_j, r_{-j}^G) + \delta \tilde{s}^P \tilde{V}^G \right] \leq \tilde{V}^G.$$

The equilibrium conditions and the optimal bailout policy are indicated in Proposition 7.

Proposition 7 *The investment decisions in equilibrium (i) and the optimal bailout policy (ii) are as follows:*

(i) *Investment decisions:*

- *Banks choose the gambling asset if*

$$\frac{\pi}{n} \leq \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{\tilde{V}^G}{\tilde{V}^P}} \right]} =: \tilde{m}^G.$$

- *Banks choose the prudent asset if*

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[\sqrt{\frac{\tilde{V}^P}{\tilde{V}^G}} - 1 \right]} =: \tilde{m}^P.$$

- *We have*

$$\tilde{m}^G > \tilde{m}^P.$$

(ii) *The optimal bailout policy is given by:*

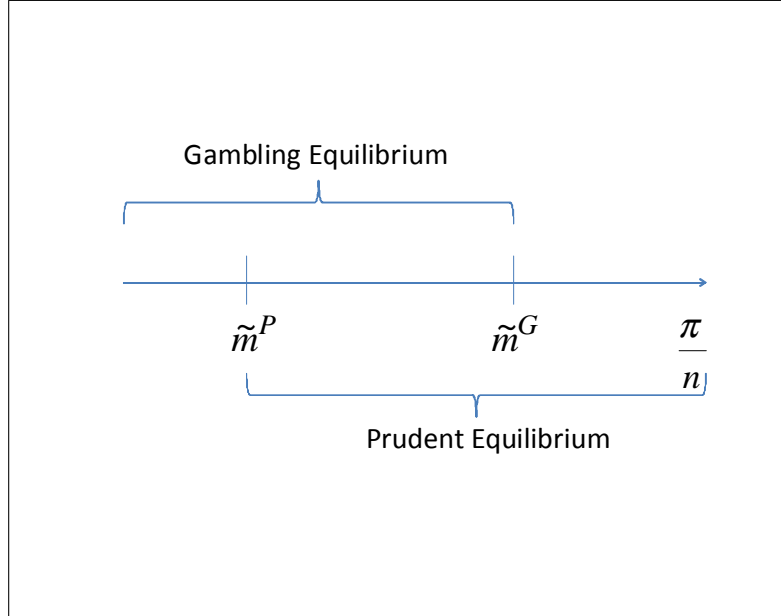
$$\begin{aligned} \beta_P^H &= \beta_P^L = 1 \\ \beta_G^H &= \beta_G^L = 0. \end{aligned}$$

Proof. For the derivation of the equilibrium conditions, consult the appendix! ■

Figure 3.3 illustrates the equilibrium conditions. Note that \tilde{m}^P and \tilde{m}^G measure the degree of competition and hence the market power of the banks. A sufficiently small number of banks, thus a sufficiently high market power, mitigates excessive risk-taking, i.e. induces banks to

choose the prudent asset. In line with the current literature, a more competitive deposit market increases deposit rates and thus decreases banks' profits, which generates higher risk level (Hellmann et al. (2000), Repullo (2004) and Boyd & De Nicoló (2005)). The area where banks gamble increases in the difference of deposit rates $r^G - r^P$.

Figure 3.3: Equilibria under symmetric information



The intuition for the optimal bailout policy is the following: As the regulator prefers prudent investments, it cannot be optimal for the regulator to favour gambling over prudent banks. The optimal strategy of the regulator is to choose the bailout probabilities β_G^H , β_G^L and β_P^H , β_P^L in such a way that \tilde{m}^P and \tilde{m}^G decrease. By doing so, the regulator minimizes the range of $\frac{\pi}{n}$ where banks gamble. Since \tilde{s}^G increases in β_G^H and β_G^L and \tilde{s}^P increases in β_P^H and β_P^L , the regulator should choose $\beta_G^H = \beta_G^L = 0$ and $\beta_P^H = \beta_P^L = 1$. Notice that there might be other equilibria, for instance, where the regulator bails out all banks independently of whether they behave prudently. This might be true if competition is so severe that the regulator's bailout policy is ineffective, i.e. if he cannot influence the banks' investment.

Due to the fact that the regulator has perfect information about the investment risk, he can punish banks investing in gambling assets. By rescuing prudent banks with probability one and gambling banks with probability zero, the regulator increases the relative bank value $\frac{\tilde{V}^P}{\tilde{V}^G}$ and thus decreases the area of the gambling equilibrium because \tilde{m}^G and \tilde{m}^P decrease. If the regulator differentiates between prudent and gambling banks, he accounts for more information than in the case of differentiating between stable and instable periods and, therefore, a differentiation between β^H and β^L cannot improve welfare.

Likewise, a bailout policy which increases the area where banks gamble does not induce banks to gamble if the banking market is too competitive. Then banks already invest in risky assets.

3.4.2 Asymmetric information on investment decisions

The information of the project risk is asymmetric as far as the investment risk is private information and the regulator cannot reveal the asset type. Hence, the regulator cannot base the bailout policy on the banks' risk behaviour and has to apply the same bailout policy for each type of bank asset. Remember that the regulator can still differentiate between H and L .

As the deposit rates do not depend on the bailout policy, banks choose again the deposit rates indicated in (3.6) and (3.8) in equilibrium. Substituting \tilde{s}^P by s^P in (3.7) and \tilde{s}^G by s^G in (3.9), we immediately obtain the bank values \hat{V}^P and \hat{V}^G (the circumflex signals that we are in the case of "asymmetric information"). The determination of the equilibrium conditions follows the same procedure as before.

Proposition 8 *The equilibrium conditions (i) and the optimal bailout policy (ii) are as follows:*

(i) *Equilibrium conditions:*

- *Banks invest in the gambling asset if*

$$\frac{\pi}{n} \leq \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{\hat{V}^G}{\hat{V}^P}} \right]} =: \hat{m}^G.$$

- *Banks invest in the prudent asset if*

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[\sqrt{\frac{\hat{V}^P}{\hat{V}^G}} - 1 \right]} =: \hat{m}^P.$$

- *We have*

$$\hat{m}^G > \hat{m}^P.$$

(ii) *The optimal bailout policy $\hat{\beta}^*$ is given by:*

$$\beta^H = 0$$

and

$$\beta^L = \begin{cases} 1 & \text{if } \frac{v^{boom}}{v^{bust}} \geq \frac{1-\delta+\delta q}{\delta q} \\ 0 & \text{if } \frac{v^{boom}}{v^{bust}} < \frac{1-\delta+\delta q}{\delta q} \end{cases}.$$

Proof. We can take the equilibrium conditions from the symmetric information case and replace \tilde{s}^G by s^G defined in (3.3) and \tilde{s}^P by s^P defined in (3.2). The derivation of the optimal bailout policy is provided in the appendix. ■

Asymmetric information hinders the distinction between "prudent" (P) and "gambling" (G) projects. However, the regulator can discriminate between "good" (H) and "bad" (L) circumstances and punish banks in state H and support banks in state L , which increases the relative charter value $\frac{\hat{v}^P}{\hat{v}^G}$. The reason is as follows: In both types of investment, the marginal increase of charter value with respect to β^H is higher than with respect to β^L . However, β^H is relatively "more important" for gambling banks and β^L is relatively more important for prudent banks. Technically speaking, gambling banks have a comparative advantage of a high β^H , whereas prudent banks have a comparative advantage of a high β^L . Consequently, a low β^H and a high β^L punishes gambling banks more than prudent banks and, therefore, the relative charter value of prudent investment increases. Intuitively, if macroeconomic conditions are good, regulators presumably rescue banks whose failure arises from risky investments. By contrast, if macroeconomic conditions are bad, failed banks rather had bad luck.

Besides, the right side of the inequation $\frac{v^{boom}}{v^{bust}} \geq \frac{1-\delta+\delta q}{\delta q}$ decreases in the discount factor δ . Hence, for higher δ , $\hat{\beta}^* = 1$ is optimal for even higher values of v^{bust} . The optimal bailout policy does not depend on the probability of project success in equilibrium, i.e. the threshold, where optimal bailout probability changes from zero to one, does not depend on p^P or/and p^G . Consequently, the optimal policy is not affected by the number of banks. However, the effectiveness of the bailout policy does depend on n . If n is too high, the banks gamble independently of the regulator's announcement, whereas in the case of sufficiently low competition they always behave prudently. Only for intermediate values of n do the banks respond to the regulator's decision and the bailout policy $\hat{\beta}^*$ and turn to prudent behaviour.

3.4.3 Imperfect information on the state of nature

Although the bailout policy, described in Proposition 8, has a clear policy implication - rescue only in times of macroeconomic distortions - its implementation can be difficult. Apart from the commitment problem, regulators have to define ex ante under which conditions they rescue. On the one hand, being too strict might cause damage to the financial system when bank failures cause contagion. On the other hand, being too accomodative increases moral hazard, as is shown below.

To see this, assume that the regulator does not perfectly know how macroeconomic conditions affect banks' probability of success. After nature has chosen H or L , the regulator receives a signal about the macroeconomic conditions. The signal is symmetric and reveals the true state of nature with probability a (Bayesian rule):

$$\text{prob}(a^H \mid \text{state} = H) = \text{prob}(a^L \mid \text{state} = L) =: a \geq 0.5.$$

Consequently, if nature chooses H , the regulator receives the right signal, i.e. the signal that conditions are good, with probability a . With probability $1-a$ he receives a wrong signal. While the regulator could previously respond to the true state of nature, he can now only respond to his signal. β_S^H denotes the bailout probability in the case where the regulator receives the signal that the macroeconomic conditions are good. To say it differently, if the regulator receives the signal that macroeconomic conditions are good, he rescues with probability β_S^H . β_S^L denotes the bailout probability for the case where the regulator receives the signal that the macroeconomic conditions are bad. Then the probability of surviving for prudent banks is given by:

$$s_S^P = q(v^{boom}p^P + (1-v^{boom}p^P)(a\beta_S^H + (1-a)\beta_S^L)) \\ + (1-q)(v^{bust}p^P + (1-v^{bust}p^P)(a\beta_S^L + (1-a)\beta_S^H))$$

and for gambling banks by:

$$s_S^G = q(v^{boom}p^G + (1-v^{boom}p^G)(a\beta_S^H + (1-a)\beta_S^L)) \\ + (1-q)(v^{bust}p^G + (1-v^{bust}p^G)(a\beta_S^L + (1-a)\beta_S^H)).$$

For example, consider the probability of surviving in the prudent case, i.e. s_S^P . Nature chooses H with probability q (first term). Hence, with probability $v^{boom}p^P$ the project is successful and the regulator does not have to intervene. With probability $(1-v^{boom}p^P)$ the project fails and the regulator rescues or liquidates. He receives the right signal with probability a , which induces him to believe that the financial market is stable (i.e. macroeconomic conditions are in favour of banks). Therefore he applies β_S^H . With probability $1-a$, he receives the wrong signal and chooses the bailout probability β_S^L , although the true state of nature is good. The second term represents the case where nature chooses L . In this case, the bank's project is successful with probability $v^{bust}p^P$. With probability $(1-v^{bust}p^P)$ the bank fails and the regulator has to intervene. Then the regulator receives the right signal with probability a , which induces him to apply β_S^L . With probability $1-a$ the signal is wrong and the regulator believes that macroeconomic conditions are good. Therefore, he chooses β_S^H although the true state of nature is low, i.e. macroeconomic conditions are bad.

The sequence of the game remains similar to the one in the previous section. Remember that \hat{V}^G is a function of s^G and that \hat{V}^P is a function of s^P . To derive the optimal bailout probabilities β_S^H and β_S^L , we only have to replace s^P by s_S^P and s^G by s_S^G in Proposition 8, where the index "S" stands for "signal". In order to keep our calculations simple, we assume $q = 0.5$.

Proposition 9 *The optimal bailout policy $\hat{\beta}_S^*$ is given:*

$$\beta_S^H = 0$$

and

$$\beta_S^L = \begin{cases} 1 & \text{if } \frac{v^{boom}}{v^{bust}} \geq \frac{2a-\delta}{\delta-2+2a} \\ 0 & \text{if } \frac{v^{boom}}{v^{bust}} < \frac{2a-\delta}{\delta-2+2a} \end{cases}.$$

Proof. The proof follows the same pattern as the proof for Proposition 8. ■

While β_S^L can be either one or zero, β_S^H always has to be zero if $a \geq 0.5$. This arises from the fact that a wrong decision in H (rescuing instead of liquidating) more than outweighs the benefit of a right decision in L (rescuing in L).

If the quality of the signal, a , decreases, $\frac{2a-\delta}{\delta-2+2a}$ increases. Consequently, the worse the signal quality, the lower the range of $\frac{v^{boom}}{v^{bust}}$, where a bailout with probability one is efficient. Hence, the regulator should only announce to bail out with probability one in L if his signal is of sufficiently good quality. In other words, if he cannot predict the impact of his conditions on the banks' probability of success, he should liquidate insolvent banks in order to avoid moral hazard.

3.5 Public bank bailouts contingent on banks' inter-connectedness

As an alternative to macroeconomic conditions, the regulator can also condition his bailout policy on the banks' systemic relevance. We model systemic relevance by assuming that the failure of one bank causes the failure of the neighbouring bank with a certain probability, denoted with c . A high c of a bank j indicates that the failure of j causes contagion with high probability. This contagion probability is the same for all banks. For the time being, we assume that a bank can only be hit by one of its neighbours. The probabilities of project success are uncorrelated. That is, the failure of one bank's project does not affect the success of the other bank's project.

As before, the regulator announces his bailout probability in advance and can credibly commit himself to it. He cannot determine the causes of the failure. Hence, if one bank fails, he does not know whether this is due to contagion or not. However, he knows the probability of contagion ex ante, for example, due to the size or/and the interconnectedness of the bank. If he rescues a bank, the bank can preserve its charter value. For example, the bailout of Commerzbank at the end of 2008 guaranteed the survival of the bank and, therefore, preserved at least parts of the charter value for the shareholders.

As the deposit rates do not depend on the probabilities of survival, they are equal to (3.8) and (3.6). For simplicity, we assume that $q = 1$ and $v^{boom} = 1$, which means that macroeconomic conditions are always in favour of the banks and that they are never hit by a shock. Thus, it remains to specify the probability of surviving. Assume both banks behave prudently. Then bank j 's probability of surviving is given by:

$$s_C^P = (p^P)^2 + p^P (1 - p^P) ((1 - c) + c\beta) + (1 - p^P) c\beta. \quad (3.10)$$

Accordingly, bank j survives if

- both projects are successful, i.e. with probability $(p^P)^2$,
- its own project is successful and the neighbour's project fails, but contagion does not occur, i.e. with probability $p^P (1 - p^P) (1 - c)$,
- its own project is successful and the neighbour's project fails and contagion occurs, but the regulator rescues, i.e. with probability $p^P (1 - p^P) c\beta$,
- its own project fails, but contagion would occur and thus the regulator rescues, i.e. with probability $(1 - p^P) c\beta$.

Equivalently, if both banks gamble, bank j 's probability of surviving is given by:

$$s_C^G = (p^G)^2 + p^G (1 - p^G) ((1 - c) + c\beta) + (1 - p^G) c\beta. \quad (3.11)$$

Even if a regulator announces to bail banks out in case of distress, the intervention process may take some time. Therefore, it might be difficult to avoid a loss for neighbouring banks. We take this into account by the fact that the regulator cannot save the neighbouring banks' profit in the period in which the failure occurs, but he can save its charter value. Consequently, the bailout policy has an impact on the banks' probability of survival, but not on their expected profit. This leads us directly to the bank value of bank j if all banks behave prudently and if all banks gamble. In the first case, the bank value is equal to (index "C" stands for "contagion"):

$$V_C^P = \frac{\delta p^P}{1 - \delta s_C^P} \frac{\pi}{n^2}$$

and, in the latter one, it amounts to:

$$V_C^G = \frac{\delta p^G}{1 - \delta s_C^G} \frac{\pi}{n^2}.$$

To derive the equilibrium conditions, we must specify the probability of survival if a bank deviates unilaterally. Assume that bank j deviates from the prudent path and chooses the gambling project. Then its probability of surviving from the deviating period t to $t + 1$ is equal to:

$$\widehat{s}_C^P = p^G p^P + p^G (1 - p^P) ((1 - c) + c\beta) + (1 - p^G) c\beta.$$

The probability of survival in case of deviation is similar to (3.10), though the deviating bank chooses p^G instead of p^P .

Equivalently, if bank j deviates unilaterally from the gambling path, its probability of surviving is given by:

$$\widehat{s}_C^G = p^P p^G + p^P (1 - p^G) ((1 - c) + c\beta) + (1 - p^P) c\beta.$$

The derivation of the equilibrium conditions follows the same steps as in Section 3.4.

Proposition 10 *The equilibrium conditions (i) and the optimal bailout policy (ii) are as follows:*

(i) *Equilibrium conditions:*

- *Banks invest in the gambling asset if*

$$\frac{\pi}{n} \leq \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{V_C^G}{V_C^P}} \right]} =: \tilde{m}_C^G.$$

- *Banks invest the prudent asset if*

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[\sqrt{\frac{V_C^P}{V_C^G}} - 1 \right]} =: \tilde{m}_C^P.$$

- *We have*

$$\tilde{m}_C^G > \tilde{m}_C^P.$$

(ii) *To reduce moral hazard, the regulator should decrease \tilde{m}_C^P and \tilde{m}_C^G . \tilde{m}_C^P decreases in β if $c \leq \frac{\delta - p^P}{\delta(1 - p^P)} =: c_L^{crit}$ whereas \tilde{m}_C^G decreases in β if $c \leq \frac{\delta - p^G}{\delta(1 - p^G)} =: c_H^{crit}$ with $c_H^{crit} > c_L^{crit}$.*

Proof. The equilibrium conditions can be derived in the same way as was described for the proof of Proposition 7. ■

The intuition is as follows: A higher bailout probability has three effects. First, a higher bailout probability β prevents a bank with a successful project from being hit by the failure of its neighbouring bank. Second, a higher bailout probability increases the banks' charter value. Both effects induce the banks to behave prudently. Third, a higher bailout probability enforces moral hazard because a failing bank is probably rescued due to its systemic relevance. In the case of sufficiently low contagion probability, the first and the second effect outweigh the moral-hazard-effect. Otherwise the moral-hazard-effect dominates and the regulator should liquidate an insolvent bank with probability one. Consequently, even if $q = 1$ and $v^{boom} = 1$, i.e. a bank is never hit by a macroeconomic shock, it might be better for the regulator to rescue in order to reduce moral hazard. This result is opposed to the findings in Dell'Ariccia & Ratnovski (2011). They find that the regulator should rescue with probability one if the contagion probability exceeds a certain threshold, though they do not account for the banks' charter value.

The regulators' optimal bailout decision is clear-cut if the banks' interconnectedness is sufficiently low or sufficiently high. In the case of $c \leq c_L^{crit}$, i.e. if the systemic relevance of the banks is sufficiently small, both \tilde{m}_C^P and \tilde{m}_C^G decrease in β and thus the regulator should

rescue with probability one. If $c \geq c_H^{crit}$, i.e. the systemic relevance is sufficiently high, \tilde{m}_C^G and \tilde{m}_C^P increase in β , consequently the regulator should liquidate with probability one.

However, in case of $c_L^{crit} < c < c_H^{crit}$, the optimal bailout policy is less clear-cut because \tilde{m}_C^G decreases in β , whereas \tilde{m}_C^P increases in β . Hence, by announcing bailout probability one, the regulator decreases the range where banks gamble, but he also decreases the range where banks behave prudently, i.e. the range, where either a prudent or a gambling equilibrium holds, decreases. Whether c_L^{crit} or c_H^{crit} is the relevant threshold depends on competition and on the equilibrium which the banks “choose”. If competition is rather low, so that the relevant equilibrium is close to \tilde{m}_C^G , c_H^{crit} might be more relevant, at least if banks choose the gambling asset in equilibrium. Otherwise (the equilibrium is close to \tilde{m}_C^P), c_L^{crit} might be the relevant threshold, at least if banks choose the prudent asset in equilibrium.

Since only less systemic banks should be rescued, the regulator’s trade-off, moral hazard versus the possibility of contagion, seems to be unavoidable. However, this is not true if the failure of one bank can affect several banks. To see this, assume each bank can be affected by the failure of any other bank. To simplify, we neglect the case that the failure of bank j causes contagion, while the failure of j ’s neighbour does not spill over to other banks. These assumptions lead us directly to the probability of surviving in the case of n banks. If all banks behave prudently, we have:

$$\bar{s}_C^P = (p^P)^n + p^P \left(1 - (p^P)^{n-1}\right) ((1 - c) + c\beta) + (1 - p^P) c\beta. \quad (3.12)$$

The last term is the same as in (3.10). The second term represents the case where bank j ’s project is successful and at least one of its neighbours’ (all banks are interconnected) projects fails. This probability is given by $1 - (p^P)^{n-1}$. Notice that $(p^P)^{n-1}$ is the probability that all projects of j ’s neighbours are successful. With probability $(p^P)^n$ all projects are successful and the regulator does not have to intervene.

Equivalently, if all banks gamble, the probability of surviving is given by:

$$\bar{s}_C^P = (p^G)^n + p^G \left(1 - (p^G)^{n-1}\right) ((1 - c) + c\beta) + (1 - p^G) c\beta. \quad (3.13)$$

The derivation of the equilibrium conditions follows the same steps as above. Similarly, in order to reduce moral hazard, the regulator should announce a bailout probability which decreases the range in which banks gamble.

Proposition 11 *A higher number of banks increases the critical thresholds.*

Proof. The equilibrium condition and the optimal bailout policy can be derived in a similar way as was described for Proposition 7 and 8. ■

The intuition is quite simple. A higher number of banks increases the probability that bank j is hit by any of its neighbours. Therefore, the benefit of a higher bailout probability increases in n . The negative effect, by contrast, remains unchanged.

To see that the probability of being hit by any of the neighbouring banks increases in n , consider the case where bank j has two neighbours. Then bank j is potentially hit by its neighbours (at least one of the neighbours is not successful) with probability (prudent case) $2p^P(1 - p^P) + (1 - p^P)^2$. Comparing this with the case where we have only one neighbour bank, we have:

$$1 - p^P < 2p^P(1 - p^P) + (1 - p^P)^2 = 1 - (p^P)^2.$$

As a result, a higher number of banks can also have a stabilizing effect if the regulator has to rescue an insolvent bank whose failure causes contagion. Then the threshold c^{crit} increases and the bailout of an insolvent bank increases risk-taking only if the probability of contagion is relatively high. For $n \mapsto \infty$, this threshold converges towards one, i.e. the regulator should then always rescue.

3.6 Conclusion

The current literature provides diverging predictions concerning the impact of bank bailouts on banks' risk-taking. Cordella & Yeyati (2003) combined two diverging channels and showed under which conditions each channel dominates. We asked whether their finding persists in a competitive banking sector where the regulator cannot perfectly foresee the impact of macroeconomic distortions on a bank's probability of survival. According to our result, an ill-suited bailout policy, i.e. a bailout policy where the regulator rescues, although he should liquidate from a welfare point of view, and vice versa, does not alter the banks' risk-taking if their charter value is low, i.e. in a competitive deposit market. The determination of macroeconomic conditions, which provide clear predictions about their impact on a bank's probability of success, is rather difficult, and the results of an inefficient bailout policy may be distortive as they enforce moral hazard. Alternatively, we show that the regulator can condition his bailout policy on the banks' systemic relevance. Then he should rescue banks which are not too relevant for the stability of the financial system. However, the critical threshold increases in the number of important banks.

We are aware that our analysis is based on several assumptions. First, we assume that banks only compete in the deposit market in an imperfect competitive framework. Second, the number of banks might only be one indicator for the degree of competition, and we are conscious that there is still a debate in the literature about its adequacy. However, competition is not the driving force for the results concerning the optimal bailout policy. It is rather important with regard to the effectiveness of a properly designed policy. Third, bank returns are uncorrelated, though banks may tend to correlate their risk exposures (Acharya & Yorulmazer (2007); Farhi & Tirole (2012)). If returns are positively correlated, the stabilizing effect of bank bailouts will become smaller and the threshold will change. However, unless returns are too correlated, a positive effect of a bank bailout remains. Fourth, the contagion probability is independent of the number of banks.

Nevertheless, this chapter provides some insights into the relation between bailouts and risk-taking behaviour of banks. First, in order to receive proper predictions about the impact of public bailout guarantees on the risk-taking of banks, empirical studies should take competition into account. Second, the bailout of systemic banks might not enforce moral hazard if enough systemic banks are in the market. Consequently, the bailout of banks which are too big to fail, does not necessarily cause moral hazard. The directive favours the bail-in tool and therefore the loss of participation of shareholders and creditors. Although this may be a step into the right direction, regulators should not demonize the bailouts of systemic banks. If a bail-in is not sufficient or not successful in a crisis scenario, a bailout of an insolvent bank could at least be considered and communicated as a "tool of last resort".

Appendix

Proof of Proposition 7

Gambling equilibrium

The necessary condition for a gambling equilibrium is:

$$\max_{r_j} \left[\delta p^P [qv^{boom} + [1 - q] v^{bust}] [\gamma^P - r_j] D_j^P (r_j, r_{-j}^G) + \delta \tilde{s}^P \tilde{V}^G \right] \leq \tilde{V}^G,$$

where the optimal deposit rate for the deviating bank fulfills the following first-order condition:

$$\delta p^P [qv^{boom} + [1 - q] v^{bust}] [\gamma^P - r_j] \frac{1}{\pi} - \delta p^P [qv^{boom} + [1 - q] v^{bust}] \left[\frac{1}{n} + \frac{r_j - r_{-j}^G}{\pi} \right] \stackrel{!}{=} 0.$$

Rearrangements lead to:

$$\gamma^P - r_j - \left[\frac{\pi}{n} + r_j - r_{-j}^G \right] = 0$$

and

$$r_j = \frac{\gamma^P - \frac{\pi}{n} + r_{-j}^G}{2}.$$

Since $\gamma^P - \frac{\pi}{n} = r^P$, we obtain (we can omit the index j and $-j$):

$$r_j^* = \frac{r^P + r^G}{2}.$$

Inserting r_j^* into the inequation above, we obtain after some rearrangements:

$$\begin{aligned} & \delta p^P [qv^{boom} + [1 - q] v^{bust}] \left[\gamma^P - \frac{r^P + r^G}{2} \right] \left[\frac{1}{n} + \frac{\frac{r^P + r^G}{2} - r^G}{\pi} \right] \\ & + \delta \tilde{s}^P \frac{\delta p^G [qv^{boom} + [1 - q] v^{bust}] \frac{\pi}{n^2}}{1 - \delta \tilde{s}^G} \\ & \leq \frac{\delta p^G [qv^{boom} + [1 - q] v^{bust}] \frac{\pi}{n^2}}{1 - \delta \tilde{s}^G} \end{aligned}$$

which can be simplified to:

$$\delta p^P \left[\gamma^P - \frac{r^P + r^G}{2} \right] \left[\frac{1}{n} + \frac{\frac{r^P + r^G}{2} - r^G}{\pi} \right] + \delta \tilde{s}^P \frac{\delta p^G}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2} \leq \frac{\delta p^G}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2}$$

and

$$p^P \left[\gamma^P - \frac{r^P + r^G}{2} \right] \left[\frac{1}{n} + \frac{\frac{r^P + r^G}{2} - r^G}{\pi} \right] + p^G \frac{\delta \tilde{s}^P - 1}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2} \leq 0.$$

In order to determine the solution of the inequation, we first solve the corresponding equation:

$$p^P \left[\gamma^P - \frac{r^P + r^G}{2} \right] \left[\frac{1}{n} + \frac{\frac{r^P + r^G}{2} - r^G}{\pi} \right] + p^G \frac{\delta \tilde{s}^P - 1}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2} = 0.$$

Simplifications and the replacement of γ^P by $r^P + \frac{\pi}{n}$ (notice that $r^P = \gamma^P - \frac{\pi}{n}$) lead first to:

$$\left[r^P + \frac{\pi}{n} - \frac{r^P + r^G}{2} \right] \left[\frac{1}{n} + \frac{\frac{r^P + r^G}{2} - r^G}{\pi} \right] + \frac{p^G}{p^P} \frac{\delta \tilde{s}^P - 1}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2} = 0$$

then to:

$$\left[\frac{\pi}{n} + \frac{r^P - r^G}{2} \right] \left[\frac{1}{n} + \frac{r^P - r^G}{2\pi} \right] + \frac{p^G}{p^P} \frac{\delta \tilde{s}^P - 1}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2} = 0$$

and finally result in:

$$\frac{\pi}{n^2} + \frac{r^P - r^G}{n} + \frac{[r^P - r^G]^2}{4\pi} + \frac{p^G}{p^P} \frac{\delta \tilde{s}^P - 1}{1 - \delta \tilde{s}^G} \frac{\pi}{n^2} = 0$$

which is equivalent to:

$$\left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} \right] \frac{\pi^2}{n^2} - [r^G - r^P] \frac{\pi}{n} + \frac{[r^G - r^P]^2}{4} = 0.$$

Remember that

$$\tilde{s}^P = q [p^P v^{boom} + [1 - p^P v^{boom}] \beta_P^H] + [1 - q] [p^P v^{bust} + [1 - p^P v^{bust}] \beta_P^L]$$

and

$$\tilde{s}^G = q [p^G v^{boom} + [1 - p^G v^{boom}] \beta_G^H] + [1 - q] [p^G v^{bust} + [1 - p^G v^{bust}] \beta_G^L].$$

Hence, in order to have

$$1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} < 0,$$

we must have $\tilde{s}^G \gg \tilde{s}^P$. Suppose $\beta_G^H = \beta_G^L = 1$ and $\beta_P^H = \beta_P^L = 0$. Then we have:

$$1 - \frac{p^G}{p^P} \frac{1 - \delta [qp^P v^{boom} + [1 - q] p^P v^{bust}]}{1 - \delta} < 0$$

if

$$\frac{p^P}{p^G} < \frac{1 - \delta [qp^P v^{boom} + [1 - q] p^P v^{bust}]}{1 - \delta}.$$

Rearrangements lead to:

$$\frac{p^P}{p^G} < \frac{1 - \delta [p^P v^{bust} + qp^P [v^{boom} - v^{bust}]]}{1 - \delta}.$$

As a result, the inequation might be fulfilled if q , v^{bust} or/and p^P is sufficiently low.

Returning to the determination of the equilibrium condition, we have to differentiate between two cases:

1. $\tilde{s}^G >> \tilde{s}^P$
2. $\tilde{s}^G > \tilde{s}^P$ or $\tilde{s}^G \leq \tilde{s}^P$.

Case 1:

The solution of the equation is given by:

$$\frac{\pi}{n_{1/2}} = \frac{[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 - 4 \frac{[r^G - r^P]^2}{4} \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}\right]}}{2 \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}\right]}$$

which is equivalent to:

$$\frac{\pi}{n_{1/2}} = \frac{[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}}{2 \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}\right]}$$

and

$$\frac{\pi}{n_{1/2}} = \frac{[r^G - r^P] \left[1 \pm \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}\right]}{2 \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}\right]}.$$

Rearrangements lead to the solutions:

$$\frac{\pi}{n_1} = \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}\right]}$$

and

$$\frac{\pi}{n_2} = \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}\right]}.$$

Since

$$\left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}\right] < 0,$$

we have a gambling equilibrium if

$$\frac{\pi}{n} \leq \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}\right]} \text{ or } \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}\right]} \leq \frac{\pi}{n}.$$

Due to the fact that the left boundary is negative, we can only have a gambling equilibrium if

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}\right]}.$$

However, the first inequation is always fulfilled if $D > 0$ (which is fulfilled by assumption since a negative amount of depositors is impossible). This is fulfilled if (remind that the deviating bank chooses r^P whereas all other banks choose r^G)

$$D(r^P, r^G) = \frac{1}{n} + \frac{r^P - r^G}{\pi} > 0$$

which is equivalent to:

$$\frac{\pi}{n} > r^G - r^P.$$

Since

$$r^G - r^P > \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}$$

we always have

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}.$$

As a result, banks always choose the gambling equilibrium. Notice that this can only result if the regulator subsidizes gambling banks more than prudent banks.

Case 2:

The solution of the equation is given by:

$$\frac{\pi}{n_{1/2}} = \frac{[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 - 4 \frac{[r^G - r^P]^2}{4} \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} \right]}}{2 \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} \right]},$$

which is equivalent to:

$$\frac{\pi}{n_{1/2}} = \frac{[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}}}{2 \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} \right]}$$

and

$$\frac{\pi}{n_{1/2}} = \frac{[r^G - r^P] \left[1 \pm \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}{2 \left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} \right]}.$$

Rearrangements lead to the solutions:

$$\frac{\pi}{n_1} = \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}$$

and

$$\frac{\pi}{n_2} = \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}.$$

Since

$$\left[1 - \frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G} \right] > 0$$

we have a gambling equilibrium if

$$\frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]} \leq \frac{\pi}{n} \leq \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}.$$

However, the first inequation is always fulfilled if $D > 0$ (which is fulfilled by assumption since a negative amount of depositors is impossible). This is fulfilled if (remember that the deviating bank chooses r^P , whereas all other banks choose r^G)

$$D(r^P, r^G) = \frac{1}{n} + \frac{r^P - r^G}{\pi} > 0$$

which is equivalent to:

$$\frac{\pi}{n} > r^G - r^P.$$

Since

$$r^G - r^P > \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}$$

we always have

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[1 + \sqrt{\frac{p^G}{p^P} \frac{1 - \delta \tilde{s}^P}{1 - \delta \tilde{s}^G}} \right]}.$$

As a result, only the right boundary is relevant and, therefore, a symmetric gambling equilibrium exists if

$$\frac{\pi}{n} \leq \frac{r^G - r^P}{2 \left[1 - \sqrt{\frac{[1 - \delta \tilde{s}^P] p^G}{[1 - \delta \tilde{s}^G] p^P}} \right]} =: \tilde{m}^G.$$

Prudent equilibrium

Equivalently, the necessary condition for a prudent equilibrium is:

$$\max_{r_j} \left[\delta p^G [q v^{boom} + [1 - q] v^{bust}] [\gamma^G - r_j] D_j^G(r_j, r_{-j}^P) + \delta \tilde{s}^G \tilde{V}^P \right] \leq \tilde{V}^P,$$

where the optimal deposit rate for the deviating bank fulfills the following first-order condition:

$$\delta p^G [q v^{boom} + [1 - q] v^{bust}] [\gamma^G - r_j] \frac{1}{\pi} - \delta p^G [q v^{boom} + [1 - q] v^{bust}] \left[\frac{1}{n} + \frac{r_j - r_{-j}^P}{\pi} \right] \stackrel{!}{=} 0.$$

Rearrangements lead to:

$$\gamma^G - \frac{\pi}{n} + r_{-j}^P = 2r_j.$$

After replacing $\gamma^G - \frac{\pi}{n}$ by r^G (we can omit the index $-j$), we obtain:

$$\frac{r^G + r^P}{2} = r_j.$$

Inserting the optimal deposit rate for the deviating bank into the equilibrium condition, we obtain:

$$\delta p^G [qv^{boom} + [1 - q]v^{bust}] \left[\gamma^G - \frac{r^G + r^P}{2} \right] \left[\frac{1}{n} + \frac{\frac{r^G + r^P}{2} - r^P}{\pi} \right] + \delta \tilde{s}^G \tilde{V}^P \leq \tilde{V}^P.$$

Taking into account that $\gamma^G = r^G + \frac{\pi}{n}$, we obtain after minor rearrangements:

$$\delta p^G [qv^{boom} + [1 - q]v^{bust}] \left[\frac{\pi}{n} + \frac{r^G - r^P}{2} \right] \left[\frac{1}{n} + \frac{r^G - r^P}{2\pi} \right] + [\delta \tilde{s}^G - 1] \tilde{V}_j^P \leq 0.$$

Inserting the bank value \tilde{V}^P and rearranging the inequation further leads to:

$$\left[\frac{\pi}{n} + \frac{r^G - r^P}{2} \right] \left[\frac{1}{n} + \frac{r^G - r^P}{2\pi} \right] + \frac{p^P}{p^G} \frac{\delta \tilde{s}^G - 1}{1 - \delta \tilde{s}^P} \frac{\pi}{n^2} \leq 0$$

which is equivalent to:

$$\frac{\pi^2}{n^2} \left[1 - \frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P} \right] + [r^G - r^P] \frac{\pi}{n} + \frac{[r^G - r^P]^2}{4} \leq 0.$$

As in the gambling case, we have to distinguish between two cases:

1. $\tilde{s}^G >> \tilde{s}^P$
2. $\tilde{s}^G > \tilde{s}^P$ or $\tilde{s}^G \leq \tilde{s}^P$

Case 1:

The solutions are given by:

$$\frac{\pi}{n^{1/2}} = \frac{-[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 - 4 \frac{[r^G - r^P]^2}{4} \left[1 - \frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P} \right]}}{2 \left[1 - \frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P} \right]}$$

which is equivalent to:

$$\frac{\pi}{n^{1/2}} = \frac{-[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 \frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}}}{2 \left[1 - \frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P} \right]}$$

and

$$\frac{\pi}{n_{1/2}} = \frac{-[r^G - r^P] \left[1 \pm \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]}{2 \left[1 - \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P} \right]}.$$

Consequently, the solutions are:

$$\frac{\pi}{n_1} = \frac{-[r^G - r^P]}{2 \left[1 + \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]}$$

and

$$\frac{\pi}{n_2} = \frac{-[r^G - r^P]}{2 \left[1 - \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]}.$$

Since

$$\left[1 - \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P} \right] > 0,$$

we have a symmetric prudent equilibrium if

$$\frac{-[r^G - r^P]}{2 \left[1 - \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]} \leq \frac{\pi}{n} \leq \frac{-[r^G - r^P]}{2 \left[1 + \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]}.$$

However, this equilibrium cannot exist because both boundary points are negative and $\frac{\pi}{n} > 0$.

Hence, we do not have a symmetric prudent equilibrium if $\tilde{s}^G \gg \tilde{s}^P$.

Case 2:

The solutions are given by:

$$\frac{\pi}{n_{1/2}} = \frac{-[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 - 4 \frac{[r^G - r^P]^2}{4} \left[1 - \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P} \right]}}{2 \left[1 - \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P} \right]}$$

which is equivalent to:

$$\frac{\pi}{n_{1/2}} = \frac{-[r^G - r^P] \pm \sqrt{[r^G - r^P]^2 \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}}}{2 \left[1 - \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P} \right]}$$

and

$$\frac{\pi}{n_{1/2}} = \frac{-[r^G - r^P] \left[1 \pm \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]}{2 \left[1 - \frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P} \right]}.$$

Consequently, the solutions are:

$$\frac{\pi}{n_1} = \frac{-[r^G - r^P]}{2 \left[1 + \sqrt{\frac{p^P}{p^G} \frac{1-\delta\tilde{s}^G}{1-\delta\tilde{s}^P}} \right]}$$

and

$$\frac{\pi}{n_2} = \frac{-[r^G - r^P]}{2 \left[1 - \sqrt{\frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}} \right]}.$$

Since

$$\left[1 - \frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P} \right] < 0$$

because

$$\frac{p^P}{p^G} > 1$$

and

$$1 - \delta \tilde{s}^G > 1 - \delta \tilde{s}^P,$$

we have a symmetric prudent equilibrium if

$$\frac{\pi}{n} \leq \frac{-[r^G - r^P]}{2 \left[1 + \sqrt{\frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}} \right]} \text{ or } \frac{-[r^G - r^P]}{2 \left[1 - \sqrt{\frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}} \right]} \leq \frac{\pi}{n}.$$

However, since $\frac{\pi}{n} \geq 0$ and

$$\frac{-[r^G - r^P]}{2 \left[1 + \sqrt{\frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}} \right]} \leq 0,$$

we can only have a prudent equilibrium if

$$\frac{\pi}{n} \geq \frac{-[r^G - r^P]}{2 \left[1 - \sqrt{\frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}} \right]}$$

which is equivalent to:

$$\frac{\pi}{n} \geq \frac{r^G - r^P}{2 \left[\sqrt{\frac{p^P}{p^G} \frac{1 - \delta \tilde{s}^G}{1 - \delta \tilde{s}^P}} - 1 \right]} =: \tilde{m}^P.$$

It can be shown without too much effort that $\tilde{m}^P < \tilde{m}^G$.

Proof of Proposition 8

To determine the optimal bailout policy, we consider the following function f which is the unique term in \hat{m}^G and \hat{m}^P depending on the bailout probability:

$$f(\beta^H, \beta^L) = \frac{p^P [1 - \delta s^G]}{p^G [1 - \delta s^P]}$$

or, equivalently,

$$f(\beta^H, \beta^L) = 1 + \frac{[p^P - p^G] [1 - \delta q \beta^H - \delta [1 - q] \beta^L]}{p^G [1 - \delta q \beta^H - \delta [1 - q] \beta^L] - \delta q p^P p^G v^{boom} [1 - \beta^H] - \delta [1 - q] p^P p^G v^{bust} [1 - \beta^L]}.$$

It is easy to show that the derivative of f with respect to β^H is negative, independent of β^L . Therefore, the optimal bailout probability is $\beta^H = 0$. If $\beta^H = 0$, the derivative of f with respect to β^L is positive if

$$v^{bust} \leq \frac{v^{boom}}{1 + \frac{1-\delta}{q\delta}}$$

and negative if

$$v^{bust} > \frac{v^{boom}}{1 + \frac{1-\delta}{q\delta}}.$$

Hence, in the first case, an insolvent bank should be bailed out with probability one, whereas it should be liquidated with probability one in the second case.

Chapter 4

Are Public Bank Bailouts Desirable From a Moral-Hazard Perspective?

4.1 Introduction

In the recent financial crisis, many banks have had to ask for public financial assistance. While some banks only needed liquidity from the central bank because the interbank market did not function properly, some banks were even bailed out through equity capital injection because these banks were perceived as systemic (Allen & Carletti (2010)). These interventions gave impetus to a new discussion about making necessary amendments in the regulatory framework in order to stabilize the banking system, to force banks to cover a share of bailout costs, and to reduce moral hazard.

In this context, the European Commission argues that a credible regime is needed which should provide for the threat of a failure. The Bank Recovery and Resolution Directive (BRRD) focuses on a bail-in tool which imposes losses on shareholders and creditors. Moreover, it allocates powers to the resolution authorities which enable them to guarantee the resolvability of institutions. Cordella & Yeyati (2003) show that such a threat is desirable, except in times of macroeconomic distortions. Dell'Ariccia & Ratnovski (2011) argue that such a threat is not desirable if banks are systemic. Similarly to Dell'Ariccia & Ratnovski (2011), we analyse the impact of bank bailouts on the risk-taking practices of banks in a setup where contagion among banks may be severe. We ask whether an international coordination of public bank bailouts or resolutions is desirable and account for the implementation of a bank resolution fund which already exists in some European countries.

To address these issues, we use a simple two-stage framework and follow a complete-contract approach. This enables the regulator and the bank to sign a contract on the interconnectedness of the banks. Consequently, at the first stage, the regulator can credibly announce a bailout policy. At the second stage, two banks invest simultaneously into a risky asset. The key ingredient is that the failure of one bank can cause the failure of the other bank. Bank returns are uncorrelated. The banks can influence the probability of a failure

by monitoring their projects, which is costly. If one bank fails, the regulator intervenes in accordance with his bailout policy, to which he is credibly committed.¹ Like Dell'Ariccia & Ratnovski (2011), we assume that the regulator can avoid contagion by rescuing the insolvent bank, but the rescued institution receives a bailout subsidy. In contrast to the model presented in Chapter 3, we use a static framework and do not take competition on the deposit market into account. We rather focus on a regulators' bailout game. These assumptions lead to the following findings:

- If the banks are equally and sufficiently systemically relevant and regulated by the same authority, a higher bailout probability leads to a higher level of monitoring effort. On the one hand, bank bailouts reduce the impact of a bank's risk decision on its probability of surviving, which encourages gambling behaviour (moral-hazard-effect). On the other hand, bank bailouts avoid the contagion of a neighbouring bank's failure, which increases the expected profit and thus induces prudent behaviour. If contagion is sufficiently severe, the latter effect outweighs the moral-hazard-effect.
- If the systemic relevance differs between two banks, the regulator may face a conflict of interests. That is, a bailout of both banks may increase the effort level of one bank, while decreasing the effort level of the other bank. This conflict of interest is particularly severe if only one bank is systemically relevant.
- If the banks are located in different countries and are regulated by their national authority, we obtain three types of Nash equilibria. The strategy combination where both regulators rescue is never a Nash equilibrium. We show under which conditions this strategy combination is Pareto efficient, which makes international cooperation desirable.
- If a resolution fund is financed by a bank levy, which depends on banks' systemic relevance, a higher bank bailout only increases the banks' monitoring effort if their contagion probability is neither too low nor too high.

This chapter proceeds as follows: In Section 4.2, we provide an overview of the literature which is related to our topic. Section 4.3 introduces the model, and Section 4.4 derives the optimal bailout policy if both banks are regulated by the same authority. We first determine the optimal bailout policy for banks which are equally relevant from a systemic point of view (basic scenario) and then for the case in which their relevance differs. In Section 4.5, we determine the Nash equilibria of the regulators' game and derive the conditions under which cooperation is desirable and/or feasible. In Section 4.6, we alter some assumption of the basic scenario and analyse the effects of a bank levy on the optimal bailout policy. Section 4.7 concludes Chapter 4.

¹Through an institutional mechanism, which is not directly addressed in this paper, he might be able to credibly commit himself to this bailout policy.

4.2 Literature review

The presented paper is related to four strands in the literature. The first strand deals with the impact of bank bailouts on the risk-taking of banks. The second strand examines contagion in banking. The third strand merges the first two and shows how bank bailouts affect risk-taking if banks are interconnected. The fourth strand points to conflicts in the case of cross-border regulation.

Beginning with the first strand, the literature differentiates between private and public bank bailouts. Perotti & Suarez (2002) argue that private bailouts, i.e. bailouts by solvent banks, are more efficient than public bailouts because the charter value of the acquiring banks increases, which induces them *ex ante* to behave more prudently. Cordella & Yeyati (2003) find that public bank bailouts can decrease a bank's portfolio risk and thus reduce moral hazard. The reason is that a higher bailout probability increases a bank's charter value, which induces it to behave more prudently (value effect). This value effect outweighs the moral-hazard-effect of bailouts if banks are only rescued in times of macroeconomic distortions and liquidated otherwise. Hakenes & Schnabel (2010) argue that an *ex ante* announced bailout of unsecured creditors can decrease the risk of the protected bank, but it increases the risk of the competitor bank.

Proceeding with the second strand, contagion in banking takes place through direct linkages between banks. Solvent banks can be hit by other banks if these banks are directly linked with each other (Rochet & Tirole (1996) and Freixas, Giannini, Hoggarth & Soussa (2000)). This is mainly due to the fact that banks do not collateralize when lending to or borrowing from each other. Hence, peer monitoring is an essential instrument to avoid a spill-over from one bank to another. Rochet & Tirole (1996) provide evidence that even in the case of interbank linkages and peer monitoring, a failure of one bank can lead to a cascade of failures. Freixas, Giannini, Hoggarth & Soussa (2000) show that the failure of one bank does not necessarily lead to a breakdown of the banking system if the banks are linked via the interbank market, because this market might serve as a diversification tool, since a proportion of the losses of a bank are transferred to other banks. Allen & Gale (2000) argue that banks hold interbank deposits in order to insure against idiosyncratic liquidity shocks. Consequently, illiquid banks withdraw their funds from liquid banks in order to meet the liquidity demands of their depositors. If the overall liquidity demand of depositors is sufficiently small, these interbank linkages are first-best. However, if there is excess demand of liquidity, i.e. the shock in one region is so high that the aggregate liquidity is too small, banks have to sell their long-term assets, which is very costly. In the case of interbank linkages, banks can sell their claims on other banks. The mutual liquidation of these assets can lead to bank runs and bank insolvencies. Hence, a crisis in one region, i.e. a liquidity shock in one region, can lead to a financial crisis in other regions.

However, this spill-over might even take place if banks are not directly linked with each other (informational contagion). Allen, Babus & Carletti (2009) and Allen & Carletti (2010)

argue that the failure of one bank can induce creditors of other banks to reassess the risks which might have been overlooked and then to withdraw their assets. Giannetti (2003) provides a similar reason for informational contagion. Since banks may be willing to renew projects with negative net present value and projects with only temporary difficulties, it might sometimes be difficult for investors to distinguish between illiquid and insolvent banks (Giannetti (2003); Goodhart (1999)). Therefore, investors charge interest rates on their deposits independently of their project type. Consequently, the failure of an insolvent bank might induce the failure of an illiquid, but solvent bank because deposit rates are too high. Information contagion can also be a reason for the spread of a crisis from one country to another. Vaugirard (2007) shows in a setup, where banks also have foreign debt in their accounts and where foreign investors have imperfect information about early liquidation yields of illiquid banks' assets, that a crisis in one country induces these investors to downgrade the liquidation yields in other countries and thus to increase lending rates. This, in turn, makes the banks more prone to illiquidity and thus to bank runs.

As part of the third strand, Morrison & White (2013) argue that a common regulator can be the reason for contagion. This is because the failure of a bank can undermine the confidence in the common banking regulator and therefore induce depositors of other banks to withdraw their funds. Public bank bailouts might avoid such a failure, but they can have a negative effect on the regulator's reputation. Morrison & White (2013) show that the benefit of public bank bailouts depends on the transparency of their action. Forcing the transparency of public bailouts *ex post* is definitely worse than allowing secret bailouts. In the case of a bailout, depositors learn that the regulator has chartered an unsound bank, which undermines the confidence in the regulator. However, *ex ante* transparency might be beneficial, especially in countries where there is only little trust in the regulator's skills. This arises from the fact that transparency *ex ante* improves investors' confidence in the system, since they know that no unsound bank is being supported by the regulator.

Leitner (2005) shows that the threat of contagion can lead to private bailouts as it induces liquid banks to rescue illiquid banks in order to avoid contagion. However, such a private solution may not exist if the liquidity is concentrated among a small group of banks, for example, because the whole network can then collapse. Then the regulator's role is to coordinate private bailouts. Acharya & Yorulmazer (2007) find that private bailouts are superior to public bank bailouts because an *ex ante* announced bailout policy leads to higher correlation among banks and thus increases the instability of the financial system. However, a sufficiently high number of insolvent banks precludes a private bailout without assistance by a regulator, since there are not enough solvent banks able to afford an acquisition. As a consequence, failed banks have to be sold to investors outside the banking sector, which leads to welfare losses since these investors lack the necessary skills. In this case, the regulator should assist solvent banks so that acquisitions become affordable (Acharya & Yorulmazer (2008)).² Similarly, Farhi &

²By contrast to Cordella & Yeyati (2003), Acharya & Yorulmazer (2007) do not consider an exogenous solvency shock, but assume that banks enforce the occurrence of a crisis by investing in similar projects.

Tirole (2012) argue that banks might follow similar investment strategies when expecting the regulator to bail out insolvent banks. Since diversification decreases, the occurrence of a crisis increases. Therefore, they propose that the regulator should require minimum liquidity and monitor the quality of liquid assets. Niepmann & Schmidt-Eisenlohr (2013) and Goodhart & Schoenmaker (2009) determine the optimal bailout policy in a multinational context. Niepmann & Schmidt-Eisenlohr (2013) find that the implementation of a multinational regulator can improve welfare if he also has fiscal power. Goodhart & Schoenmaker (2009) show that sharing *ex ante* the burden of bank bailouts can be welfare efficient, especially when the burden is shared by countries which are directly affected by the failure of an institution. Closest to our paper is Dell'Ariccia & Ratnovski (2011), as they also determine the effect of a higher bailout policy on the effort level of banks if contagion among these banks is possible.

As part of the fourth strand, Acharya (2003) shows that the harmonization of closure policies has to be linked to the harmonization of capital controls. He argues that banks in more forbearing countries choose higher risks than banks in less forbearing countries, which reduces the charter value of the latter ones. In order to avoid the exit of banks in less forbearing countries, central banks in these countries have to adopt the same policy as central banks in more forbearing countries, which induces a race to the bottom. Dell'Ariccia & Marquez (2006) show that competition between national regulators can lead to suboptimally low standards. Beck, Todorov & Wagner (2011) argue that cross-border activities can disrupt the domestic regulator's incentives to intervene, and the implementation of a multinational regulator might be beneficial from a welfare point of view. Espinosa-Vega, Kahn, Sole & Matta (2011) consider regulatory agencies' forbearance and information sharing incentives. They show that regulators might be more forbearing towards systemically important institutions. When some regulators have access to information concerning the degree of systemic relevance of an institution, they have little incentives to share this information with other regulators. Huizinga, Bertay & Demirgüç-Kunt (2011) provide evidence that internationally active banks have a disadvantage compared to national banks, since they receive fewer implicit subsidies from the safety net. This results in higher funding costs for multinational banks and therefore national safety nets might create a burden to the internationalization of banks. Similarly, we model the interaction and incentives of different regulators. By contrast to Acharya (2003) and Dell'Ariccia & Marquez (2006), we focus on bailouts as the regulator tool and exclude capital requirements. As in Espinosa-Vega et al. (2011), the systemic relevance of the institutions plays an important role, although information sharing between regulators is out of the focus of the model presented below.

The model presented in the next section focuses on public bank bailouts. As in Cordella & Yeyati (2003) and Hakenes & Schnabel (2010), we ask how public bank bailouts affect the risk-taking behaviour of banks. We follow the idea of Morrison & White (2013) and assume that the failure of one bank can induce the failure of another bank even though the banks are not directly linked to each other and asset returns are uncorrelated. While Morrison & White (2013) argue that a common regulator might be the channel through which contagion occurs,

we assume that there is an indirect bank exposure which cannot be managed by the banks. Dell'Ariccia & Ratnovski (2011) provide the following intuition: If a bank fails, it can cause a recession which then induces the failure of the competitor bank's borrowers.³ The model presented in this paper differs in three points from Dell'Ariccia & Ratnovski (2011). Firstly, we allow for heterogeneity among the banks. While Dell'Ariccia & Ratnovski (2011) assume that the contagion probability for both banks is the same, i.e. both banks reveal the same systemic relevance, we analyse the impact of a bailout policy on banks which differ in their systemic relevance. Secondly, we show under which conditions internationally coordinated bank bailouts are desirable or/and feasible. Thirdly, we also consider possible fundings of these bank bailouts and ask how a bank levy affects the optimal bailout policy. In contrast to Leitner (2005), we only consider two banks and do not consider a network of different banks. Finally, banks in our model do not choose their interconnection through investments in similar projects. This might trigger a crisis as is modeled in Acharya & Yorulmazer (2008) and Farhi & Tirole (2012). We rather offer an alternative way of interconnection through contagion via macroeconomic feedbacks. In this case, bank bailouts can have a positive effect on the risk-taking of banks if this feedback is sufficiently high. By contrast to Niepmann & Schmidt-Eisenlohr (2013) and Goodhart & Schoenmaker (2009), we also model the risk incentives of potentially bailed out banks, depending on who rescues them. We also show under which condition an internally coordinated bailout is desirable.

4.3 The model

4.3.1 Players and action sets

We consider the following groups of risk-neutral players: two banks, a regulator (two regulators in Section 4.5) who decides about the bailout policy, and secured depositors. The players neither have time preferences nor opportunity costs and only consume at the end of the investment period. Hence, we neglect any liquidity problems resulting from the fact that depositors withdraw their funds during the investment period.

Depositors and banks

The demand of deposits is constant and equal to one. Depositors receive a payoff of one, independently of whether they deposit their funds in bank i or j . The deposit rate is normalized to zero. This assumption differs from the previous chapter, where the deposit rate is endogenous. Since the depositors' payoff does not depend on the banks' investment decision, they do not have an incentive to monitor banks. In combination with limited liability, this is one reason for moral hazard.

³Beck et al. (2010) argue that this kind of boomerang effect took place during the recent crisis, as the distress of banks had an impact on non-bank financial institutions, which increased the distress of commercial banks.

Each bank, i and j , collects one unit of deposits and finances its risky investment by offering secured deposits. As in the previous chapters, we could assume that each bank also collects equity capital of an infinitesimal unit in order to ensure that banks are owned by shareholders. However, as in the previous chapter, this assumption is irrelevant for the results of the model.

Neglecting contagion among banks, bank i receives a payoff of $R > 1$ with probability q_i and a payoff of zero with probability $1 - q_i$. Bank i can influence q_i by monitoring its creditors. While a higher monitoring effort q_i increases the probability of project success, it is costly. These costs are equal to $\frac{1}{2}\lambda q_i^2$, where λ measures the cost efficiency of the bank. The banks are homogenous with regard to their net payoff, but they may differ with regard to their systemic importance. Therefore, we differentiate between two scenarios. In the basic scenario (Section 4.4.1), the banks are equally relevant for the stability of the financial system. In the second scenario (Section 4.4.2), their systemic relevance can differ.

The relevance of the banks for the stability of the financial system (interconnectedness) is represented by their probability of contagion which is denoted with c . It implements a component into the probability of success which is not under control of the bank. The banks have imperfect information about their own systemic relevance and the one of their neighbours, i.e. they are only aware of c . This may at least be reasonable for banks which are not globally systemic. However, even global players may not be fully aware about the impact of their failure on other institutions.

The contagion probability is supposed to be public information and to be verifiable by a third party (complete-contract approach). The possibility of contagion implies that bank i can generate its net payoff $R - 1$ if both projects are successful or if contagion does not occur in the case of a failure of its neighbour j . Moreover, for simplicity, both projects are independent, i.e. the correlation of project returns is zero. In the case of homogeneity among the banks and the absence of any regulatory intervention, bank i 's expected net payoff can therefore be written as (the expected profit of bank j is equivalent):

$$\Pi_i(q_i, q_j) = (q_i q_j + q_i (1 - q_j) (1 - c)) (R - 1) - \frac{1}{2} \lambda (q_i)^2.$$

The first part is the expected payoff of the project, while the second term represents the monitoring costs. Bank i can generate the payoff $R - 1$ with probability $q_i q_j$ (both banks are successful) and, if the failure of bank j does not cause contagion, i.e. with probability $q_i (1 - q_j) (1 - c)$. We assume $\lambda > (R - 1)$.

Regulator

The regulator aims at maximizing the effort levels of banks. At an initial point of time, each bank receives a license to operate. The complete-contract approach used in this setup enables the regulator and the banks to sign a contract which promises a certain bailout policy depending on the interconnectedness of the banks, i.e. c . Consequently, the regulator can

credibly announce and commit himself to a bailout policy *ex ante*. Bailout means that the bank survives and that it can achieve a positive terminal value. We model this terminal value as percentage η of the project's net payoff. This is the second reason for moral hazard ("costs" of a bailout). However, the bailout of an insolvent bank avoids contagion and thus the failure of the neighbouring bank ("revenue" of a bailout).

Hence, an increase of the bailout probability protects a healthy bank from contagion, but it subsidizes the failed bank. In the presence of a regulator, the expected net payoff of bank i can be written as:

$$\Pi_i(q_i, q_j) = (q_i q_j + q_i (1 - q_j) (1 - c + c\beta) + (1 - q_i) \eta \beta) (R - 1) - \frac{1}{2} \lambda (q_i)^2, \quad (4.1)$$

where $\eta < 1$ measures the subsidy that shareholders receive when the bank is rescued (Dell'Ariccia & Ratnovski (2011)). It can be interpreted as a bailout efficiently, i.e. the regulator's ability to avoid contagion without subsidizing a gambling bank. For example, suppose $\eta = 0$. Then the regulator can rescue the failed bank without subsidizing it because its payoff is then zero (which is equivalent to the payoff in the absence of any regulatory intervention). By contrast, if $\eta = 1$, the regulator rescues, and shareholders receive the whole charter value of the bank. Then he is not able to avoid contagion without subsidizing the bank. The bailout of Commerzbank may be an example for $0 < \eta < 1$. As the German regulator did not nationalize the bank, shareholders still participate in future gains of the bank, i.e. $\eta > 0$. However, as the regulator owns shares, the shareholders do not receive the whole stake, i.e. $\eta < 1$.

4.3.2 Sequence of events

The game has two stages. At the first stage, the regulator announces and credibly commits himself to a bailout policy. At the second stage, both banks choose their monitoring effort simultaneously. Thereafter, nature reveals the outcome of the project and payoffs are realized. If a bank fails, either due to contagion or due to its own project failure, the regulator rescues or liquidates in accordance with the bailout policy announced at the beginning.

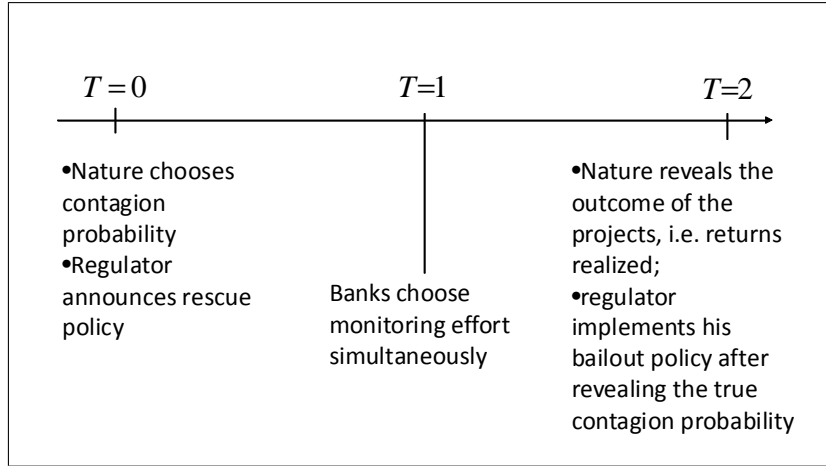
Figure 4.1 illustrates the sequence of the game.

4.3.3 Equilibrium concept

We focus on subgame perfect equilibria. Therefore, we solve the game by backward induction, beginning with the last stage where banks choose their effort levels. Taking the banks' decision into account, we determine the optimal bailout policy for the regulator at the first stage.

Further below, we have two regulators who simultaneously decide about their bailout policy at the first stage of the game.

Figure 4.1: Sequence of events



4.4 Public bank bailouts by a national regulator

4.4.1 Symmetric contagion probability

Each bank i and j seeks to maximize its net expected profit, which is equal to the expected payoff at the end of the investment period minus the monitoring costs at the beginning. The regulator rescues with probability β and liquidates with probability $1 - \beta$. Consequently, bank i faces the following maximization problem:

$$\max_{q_i} \left[(q_i q_j + q_i (1 - q_j) (1 - c + c\beta) + (1 - q_i) \eta \beta) (R - 1) - \frac{1}{2} \lambda q_i^2 \right]. \quad (4.2)$$

Bank i 's reaction function equals (the index " R " stands for "reaction function"):

$$q_i^R = (q_j + (1 - q_j) ((1 - c) + c\beta) - \eta \beta) \frac{(R - 1)}{\lambda}.$$

We immediately see that q_i and q_j are strategic complements. Hence, q_i^R increases in q_j , and q_j^R increases in q_i . Moreover, q_i^R increases in R and decreases in λ . Since the effort levels are strategic complements, we already know that the effort levels in equilibrium will increase in R and decrease in λ . This is quite intuitive. Higher project returns increase the benefit of monitoring the projects (direct effect). Due to the fact that a higher effort level of i (j) increases the expected payoff of j (i), i (j) has higher incentives to behave prudently. The impact of β on the effort level in equilibrium depends on c and η . To see this, consider the efforts in Nash equilibrium (the index " N " stands for "Nash equilibrium"):

$$q_i^N = q_j^N = \frac{(1 - c(1 - \beta) - \beta \eta) (R - 1)}{\lambda - c(1 - \beta) (R - 1)}.$$

A higher bailout probability β has two effects. First, it increases q_i^N and q_j^N because it

reduces the probability of contagion. Second, it reduces the effort level because it raises the payoff in case of insolvency and thus causes moral hazard.

Proposition 12 *To increase the monitoring effort of the banks, the regulator should only rescue with probability one if $c > c^{crit}$, with*

$$c^{crit} := \frac{\lambda\eta}{R\eta + \lambda - \eta - (R - 1)}.$$

c^{crit} increases in η if $\lambda - R + 1 > 0$.

Proof. The proof is provided in the appendix. ■

Similarly to Dell'Ariccia & Ratnovski (2011), a bank bailout has a stabilizing effect on the financial system if the rescued banks are sufficiently systemically relevant, i.e. the probability of contagion is beyond a certain threshold. Hence, a bank bailout may not only be beneficial from the view point of costs, but also from the view point of risk. The reason is similar to the argument of Cordella & Yeyati (2003). A higher bailout probability decreases the probability of default if the failure is due to bad luck rather than the consequence of bad incentives (excessive risk-taking). While in Cordella & Yeyati (2003), this component is represented by the macroeconomic environment, in this framework, it is the contagion probability.

Besides, a higher expected profit increases the critical contagion threshold. Consequently, regulatory measures which decrease banks' profits independent of their systemic relevance, should involve a bailout for even less relevant banks in order to stabilize the financial system. A higher η has the same effect on c^{crit} because it supports the negative effect of bailout. Proposition 12 also explains that a less efficient banking system, where λ is rather high, should evoke a more generous bailout policy.

4.4.2 Asymmetric contagion probability

Now we allow for heterogeneity of the banks with regard to their relevance for the stability of the financial system. Therefore, we assume that i causes contagion with probability c_i and j with probability c_j . Then, we have

$$q_i^R(q_j) = (q_j + (1 - q_j)((1 - c_j) + c_j\beta) - \eta\beta) H$$

as the reaction function of bank i , where $H := \frac{R-1}{\lambda}$, and

$$q_j^R(q_i) = (q_i + (1 - q_i)((1 - c_i) + c_i\beta) - \eta\beta) H$$

as j 's reaction function.

We determine the optimal bailout policy if the regulator rescues (liquidates) both banks with the same probability. Following this scenario, we ask under which condition a regulator induces bank j to choose a higher monitoring effort if he rescues with probability one than

if he liquidates with probability one. In the case of a bailout with probability one, the effort levels in equilibrium are given by:

$$q_i^N = (1 - \eta) H$$

and

$$q_j^N = (1 - \eta) H.$$

As a result, the monitoring effort of bank i in equilibrium does not depend on the effort level of bank j and vice versa. Intuitively, if bank i knows that it will be rescued with probability one in case of failure, the failure of bank j does not play any role in its risk decision.

If the banks are liquidated with probability one in the case of a failure, the effort levels in equilibrium are given by:

$$q_i^N = \frac{H}{c_j H^2 c_i - 1} (c_j - 1 - c_j H + c_j H c_i)$$

and

$$q_j^N = \frac{H}{c_j H^2 c_i - 1} (c_i - 1 - c_i H + c_j H c_i).$$

Obviously, if the regulator announces the liquidation of both banks in the case of a failure, they will take the possibility of contagion into account.

Proposition 13 *To increase bank i 's effort level, the regulator should rescue both banks with probability one if*

$$c_j > \frac{\eta}{(1 - H + H c_i - (1 - \eta) H^2 c_i)} =: c_j^{crit}.$$

To increase bank j 's effort level, the regulator should rescue both banks with probability one if

$$c_i > \frac{\eta}{(1 - H + H c_j - (1 - \eta) H^2 c_j)} =: c_i^{crit}.$$

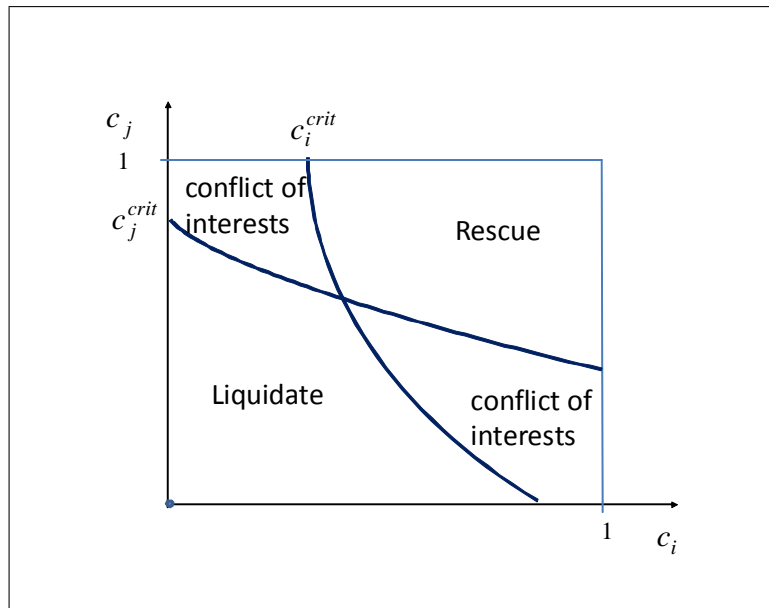
c_j^{crit} and c_i^{crit} increase in H and η .

Proof. The proof is provided in the appendix. ■

Figure 4.2 illustrates the optimal bailout policy for a regulator who aims at maximizing the effort levels of bank i and bank j . If both banks are sufficiently systemically relevant, the regulator rescues with probability one, whereas in the case of a sufficiently low contagion probability, both banks are liquidated. Notice that rescuing both banks increases both monitoring efforts, even if the contagion probabilities differ, but both exceed a sufficiently high threshold.

Moreover, Proposition 13 suggests that regulation measures, which lead to a decrease in banks' net payoffs, should lead to a change of the regulators' bailout policy in such a way that banks are also rescued if their contagion probability, i.e. systemic relevance, is low. Furthermore, a higher η benefits banks whose project has failed and thus raises incentives to gamble. Therefore, the regulator should only rescue banks if the contagion probabilities are sufficiently high in order to outweigh the negative effect of a bailout.

Figure 4.2: Conflict of interests in the case of asymmetric contagion probabilities



If the contagion probability of one bank is high and the contagion probability of the other bank low, the regulator should rescue both banks in order to increase the effort level of the bank with the low contagion probability and liquidate both banks to increase the effort level of the other bank. Hence, the regulator faces a conflict of interest. This raises the question of whether a regulator should discriminate between i and j and rescue i with probability β_i and j with probability β_j .

4.5 International coordination of public bank bailouts

We assume that bank i is located in the domestic (home) country and regulated by a domestic (home) regulator who aims at maximizing i 's effort level. Bank j is supposed to be located in a foreign (host) country and regulated by a foreign (host) regulator who aims at maximizing j 's effort level. Therefore, the regulators may apply different bailout policies. If the regulator can differentiate between bank i and j and apply individual bailout policies, we may have two different scenarios.

1. In the scenario "high protection possibility", if the foreign bank j fails, the domestic regulator can protect the domestic bank also in case that the foreign bank is not rescued by the foreign regulator. This scenario may occur when the failure of bank j can cause the failure of bank i , but the domestic regulator is able to support the domestic bank. The same holds true vice versa. This scenario may be adequate for large countries which can stabilize their banks through equity injection, for example, even if the foreign banks are not supported by their regulator.
2. In the scenario "medium protection possibility", if the foreign bank j fails, the domestic

regulator cannot protect the domestic bank in case that the foreign bank is liquidated. One reason may be the fact that the home regulator cannot afford such a protection. The same holds true vice versa. This scenario may be adequate for medium countries which cannot stabilize their bank if the foreign bank fails. A "small protection possibility" would even enable the regulator to protect the bank in its own country if this bank has failed. Note that protecting a bank from failure in case that the foreign bank fails is different than rescuing a failed bank in its own country. The reason may be second and third round effects. For example, the failure of a foreign bank may cause the failure of other foreign banks which in turn has again an effect on the domestic bank.

4.5.1 High protection possibility

Again, we apply backward induction and begin with the banks' choice of effort at the second stage. Then we determine the optimal bailout strategies for the regulators on the first stage. There we focus on pure strategies, which means that the domestic and the foreign regulator can either rescue with probability one or liquidate with probability one. Note that each regulator can only protect its domestic bank, i.e. the home country regulator can only protect bank i and the host country regulator can only protect bank j .

We denote the probability that bank i is rescued by the home regulator with β_i and that bank j is rescued by the foreign (host) regulator with probability β_j . Then bank i 's maximization problem is the following:

$$\max_{q_i} \left[(q_i q_j + q_i (1 - q_j) (1 - c_j + c_j (\beta_j + \beta_i - \beta_j \beta_i))) + (1 - q_i) \eta \beta_i \right] (R - 1) - \frac{1}{2} \lambda q_i^2 \Big].$$

Notice that $\beta_j + \beta_i - \beta_j \beta_i = \beta_j \beta_i + \beta_j (1 - \beta_i) + \beta_i (1 - \beta_j)$. The intuition for the objective function is the following: Bank i survives, i.e. obtains the return $(R - 1)$, if (i) both projects are successful ($q_i q_j$), if (ii) bank i 's project is successful and bank j fails ($q_i (1 - q_j)$), but its failure does not cause contagion ($1 - c_j$) or, if so, the failure of bank i is avoided ($c_j (\beta_j + \beta_i - \beta_j \beta_i)$), and if (iii) bank i 's project fails, but it is rescued ($(1 - q_i) \eta \beta_i$). In case (ii), bank i survives the failure of bank j in case of contagion if either both banks are protected ($\beta_j \beta_i$) or bank j is rescued ($\beta_j (1 - \beta_i)$) or bank i is protected ($\beta_i (1 - \beta_j)$).

Bank i 's reaction function is given by:

$$q_i^R = (q_j + (1 - q_j) (1 - c_j + c_j (\beta_j + \beta_i - \beta_j \beta_i)) - \eta \beta_i) H.$$

Remember that $H := \frac{R-1}{\lambda}$.

The equivalent maximization problem holds true for bank j :

$$\max_{q_j} \left[(q_j q_i + q_j (1 - q_i) (1 - c_i + c_i (\beta_i + \beta_j - \beta_j \beta_i))) + (1 - q_j) \eta \beta_j \right] (R - 1) - \frac{1}{2} \lambda q_j^2 \Big].$$

Bank j 's reaction function is equal to:

$$q_j^R = (q_i + (1 - q_i) (1 - c_i + c_i (\beta_j + \beta_i - \beta_j \beta_i)) - \eta \beta_j) H.$$

Now we turn to the bailout decision at stage one. Considering only pure strategies of the regulators, we have four strategy combinations: both banks are rescued, both banks are liquidated, bank i is rescued and bank j is liquidated, and bank j is rescued and bank i is liquidated. Henceforth, we write R for "rescue (with probability one)" and L for "liquidate (with probability one)". The payoffs are indicated in Figure 4.3. Some intermediate steps are provided in the appendix.

Proposition 14 *The following strategy combinations are Nash equilibria:*

1. (R, L) if $c_i > \hat{c}_i^{crit}$,
2. (L, R) if $c_j > \hat{c}_j^{crit}$,
3. (L, L) if $c_i < \hat{c}_i^{crit}$ and $c_j < \hat{c}_j^{crit}$, where

$$\hat{c}_i^{crit} := \frac{\eta + c_j H - c_j}{c_j H (1 - (1 - \eta) H)}$$

and

$$\hat{c}_j^{crit} := \frac{\eta + c_i H - c_i}{c_i H (1 - (1 - \eta) H)}.$$

Proof. The appendix provides some intermediate steps for the equivalence between $c_i > \hat{c}_i^{crit}$ and

$$(1 - \eta) H > \frac{H (c_i - 1) + \frac{1}{c_j} (c_j - 1)}{H c_i - \frac{1}{c_j H}}.$$

Similarly, $c_j > \hat{c}_j^{crit}$ is equivalent to:

$$(1 - \eta) H > \frac{H (c_j - 1) + \frac{1}{c_i} (c_i - 1)}{H c_j - \frac{1}{c_i H}}.$$

Consider (R, L) . A unilateral deviation is not beneficial for the host regulator because $H > (1 - \eta) H$. A unilateral deviation is not beneficial for the home regulator if $c_i > \hat{c}_i^{crit}$, which is equivalent to $(1 - \eta) H > \frac{H (c_i - 1) + \frac{1}{c_j} (c_j - 1)}{H c_i - \frac{1}{c_j H}}$. Hence, this strategy combination is a Nash equilibrium if $c_i > \hat{c}_i^{crit}$. Consider (L, R) . A unilateral deviation is not beneficial for the home regulator because $H > (1 - \eta) H$. A unilateral deviation is not beneficial for the host regulator if $c_j > \hat{c}_j^{crit}$, which is equivalent to $(1 - \eta) H > \frac{H (c_j - 1) + \frac{1}{c_i} (c_i - 1)}{H c_j - \frac{1}{c_i H}}$. Hence, (L, R) is a Nash equilibrium as long as $c_j > \hat{c}_j^{crit}$. Consider (L, L) . This strategy combination is a Nash equilibrium if neither the home regulator has an incentive to deviate, which holds true

Figure 4.3: Payoffs in the case of high protection possibility
Host regulator

| | | Host regulator | |
|----------------|-----|------------------------------|--|
| | | R | L |
| Home regulator | R | $(1 - \eta) H, (1 - \eta) H$ | $(1 - \eta) H, H$ |
| | L | $H, (1 - \eta) H$ | $\frac{H(c_i-1)+\frac{1}{c_j}(c_j-1)}{Hc_i-\frac{1}{c_jH}}, \frac{H(c_j-1)+\frac{1}{c_i}(c_i-1)}{c_jH-\frac{1}{Hc_i}}$ |

if $c_i < \hat{c}_i^{crit}$, nor the host country regulator wants to deviate and rescue, which holds true if $c_j < \hat{c}_j^{crit}$. ■

In this scenario, the implementation of a multinational regulator cannot improve welfare if welfare improvements are defined as an increase of the payoff of one regulator without decreasing the payoff of the other regulator (Pareto improvements). Hence, the strategy combinations in the Nash equilibria are Pareto efficient. To see this, consider (i) the strategy combination (R, L) . If this strategy combination is an equilibrium, a multinational regulator can not improve welfare by choosing (L, L) or (R, R) . Otherwise, (R, L) would not be a Nash equilibrium. Consider the strategy combination (L, R) . In this strategy combination the home regulator would be better off than in (R, L) , but the host regulator's payoff would be lower. If (ii) the strategy combination (L, R) is obtained in equilibrium, a multinational regulator could not improve by choosing another strategy combination, either. This must be true due to symmetry. Finally, if (iii) the strategy combination (L, L) is reached in equilibrium, a multinational regulator could not improve welfare by choosing (R, L) or (L, R) due to the definition of a Nash equilibrium. Welfare would not be improved either if the regulator chose (R, R) because $(1 - \eta) H < \frac{H(c_i-1)+\frac{1}{c_j}(c_j-1)}{Hc_i-\frac{1}{c_jH}}$.

However, the implementation of a multinational regulator, who takes the effort levels of both banks into account, may be better for the host regulator than a resolution scenario, where the home regulator becomes the single resolution authority. To see this, assume that bank j is a subsidiary of bank i . The home regulator would always choose (L, R) if $H > \frac{H(c_i-1)+\frac{1}{c_j}(c_j-1)}{Hc_i-\frac{1}{c_jH}}$, for example. However, in this case, the host country regulator is worse off than in case of (R, L) , which would be the Nash equilibrium if $c_i > \hat{c}_i^{crit}$ (this entails $H > \frac{H(c_i-1)+\frac{1}{c_j}(c_j-1)}{Hc_i-\frac{1}{c_jH}}$) and $c_j < \hat{c}_j^{crit}$. Therefore, the host regulator may not agree to a resolution strategy, where the home regulator is the leading authority.

This should be taken into account when discussing whether a "multiple-point-of-entry approach" (MPE) or a "single-point-of-entry approach" (SPE) is regarded as the adequate resolution approach. The Bank Recovery and Resolution Directive allows for both approaches. Therefore, the decision on the approach has to be made in the supervisory colleges. The SPE

involves the application of resolution powers by a single resolution authority. The SPE strategy usually aims to insure a going-concern of the subsidiaries by absorbing losses within the group. This loss absorption may be combined with a resolution tool, such as a bail-in of debt, or a transfer of assets and liabilities to a bridge bank. However, an SPE approach may not ensure the going-concern of a subsidiary if the resolution tool is not successful. An MPE involves the application of resolution powers by more than one resolution authorities to different parts of the group. This approach may result in a break-up of the group.⁴

4.5.2 Medium protection possibility

While in the scenario "high protection possibility", bank i can generate $(R - 1)$ with probability $\beta_j + \beta_i - \beta_j \beta_i$ if j fails and causes contagion, it only receives the net payoff with probability β_j in this scenario. Again, we begin with the second stage, where the banks choose their monitoring effort. Thus, bank i 's maximization problem can be written as (bank j 's maximization problem is equivalent):

$$\max_{q_i} \left[(q_i q_j + q_i (1 - q_j) (1 - c_j + c_j \beta_j) + (1 - q_i) \eta \beta_i) (R - 1) - \frac{1}{2} \lambda q_i^2 \right],$$

where bank i 's reaction function is given by:

$$q_i^R = (q_j + (1 - q_j) (1 - c_j + c_j \beta_j) - \eta \beta_i) H.$$

Equivalently, bank j 's objective function is equal to:

$$\max_{q_j} \left[(q_i q_j + q_j (1 - q_i) (1 - c_i + c_i \beta_i) + (1 - q_j) \eta \beta_j) (R - 1) - \frac{1}{2} \lambda q_j^2 \right].$$

The reaction function of bank j is equal to:

$$q_j^R = (q_i + (1 - q_i) (1 - c_i + c_i \beta_i) - \eta \beta_j) H.$$

At the first stage of the game, the regulators decide whether to rescue or to liquidate in emergency. Again, we have to consider four strategy combinations: both regulators rescue, both regulators liquidate, the home regulator rescues and the host regulator liquidates, the home regulator liquidates and the host regulator rescues. Figure 4.4 summarizes the payoffs for each strategy combination. Again, some intermediate steps are provided in the appendix.

Proposition 15 *The following strategy combinations are Nash equilibria:*

1. (R, L) if $c_i > \tilde{c}_i^{crit}$,
2. (L, R) if $c_j > \tilde{c}_j^{crit}$,

⁴See http://www.financialstabilityboard.org/publications/r_130716b.pdf (5 May 2014).

Figure 4.4: Payoffs in the case of medium protection possibility
Host regulator

| | | R | L |
|----------------|-----|--------------------------------------|--|
| Home regulator | R | $(1 - \eta) H, (1 - \eta) H$ | $(H + (1 - H)(1 - c_j) - \eta) H, H$ |
| | L | $H, (H + (1 - H)(1 - c_i) - \eta) H$ | $\frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{Hc_i - \frac{1}{c_j H}}, \frac{H(c_j - 1) + \frac{1}{c_i}(c_i - 1)}{c_j H - \frac{1}{Hc_i}}$ |

3. (L, L) if $c_j < \tilde{c}_j^{crit}$ and $c_i < \tilde{c}_i^{crit}$, where

$$\tilde{c}_i^{crit} := \frac{\eta}{Hc_j [1 + \eta H - c_j H^2 + c_j H - H]}$$

and

$$\tilde{c}_j^{crit} := \frac{\eta}{Hc_i [1 + \eta H - c_i H^2 + c_i H - H]}.$$

Proof. The appendix provides some intermediate steps for the equivalence between $c_i > \tilde{c}_i^{crit}$ and

$$(H + (1 - H)(1 - c_j) - \eta) H > \frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{Hc_i - \frac{1}{c_j H}}$$

as well as between $c_j > \tilde{c}_j^{crit}$ and

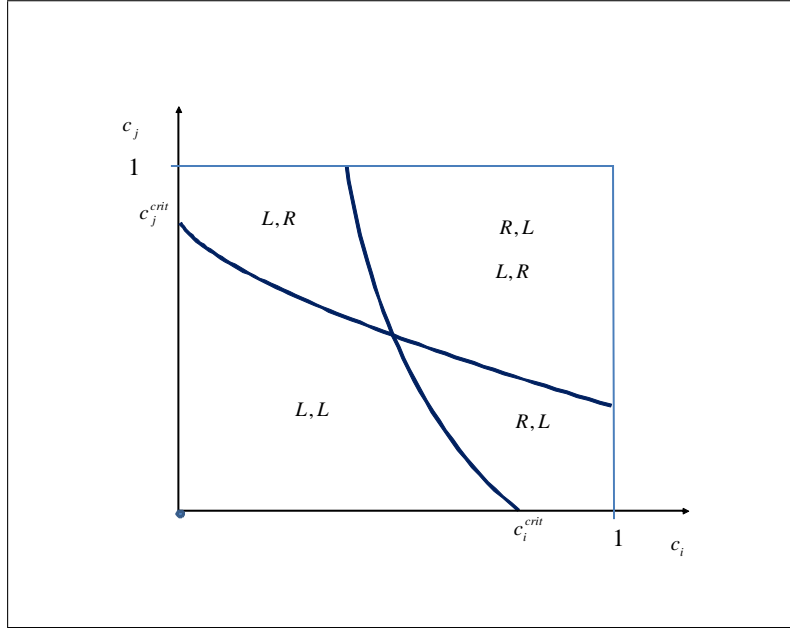
$$(H + (1 - H)(1 - c_i) - \eta) H > \frac{H(c_j - 1) + \frac{1}{c_i}(c_i - 1)}{c_j H - \frac{1}{Hc_i}}.$$

Consider the strategy combination (R, L) . The host regulator does not have an incentive to deviate because R leads to a lower monitoring effort due to the fact that $H > (1 - \eta) H$. The home regulator cannot beneficially deviate if $c_i > \tilde{c}_i^{crit}$, which is equivalent to $(H + (1 - H)(1 - c_j) - \eta) H > \frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{Hc_i - \frac{1}{c_j H}}$. Hence, this strategy combination is a Nash equilibrium if $c_i > \tilde{c}_i^{crit}$. Consider the strategy combination (L, R) . The home regulator cannot beneficially deviate because $H > (1 - \eta) H$. The host regulator does not have an incentive to deviate if $c_j > \tilde{c}_j^{crit}$, which is equivalent to $(H + (1 - H)(1 - c_i) - \eta) H > \frac{H(c_j - 1) + \frac{1}{c_i}(c_i - 1)}{c_j H - \frac{1}{Hc_i}}$. Hence, this strategy is a Nash equilibrium if $c_j > \tilde{c}_j^{crit}$. Consider (L, L) . This strategy combination is a Nash equilibrium if neither the home regulator has an incentive to deviate, which holds true if $c_i < \tilde{c}_i^{crit}$, nor the host country regulator wants to deviate and rescue, which holds true if $c_j < \tilde{c}_j^{crit}$. ■

Figure 4.5 illustrates the functions \tilde{c}_i^{crit} and \tilde{c}_j^{crit} . It can be shown that the first derivative

of c_i^{crit} (c_j^{crit}) decreases in c_j (c_i) and that the second derivative increases in c_j (c_i).⁵

Figure 4.5: Equilibria in the regulators' game



As a result, if c_i and c_j are sufficiently large, we have two equilibria in pure strategies, where one of the regulators rescues and the other regulator liquidates with probability one. By contrast, in case of a high c_i and a low c_j there is one equilibrium in pure strategies where the domestic regulator rescues with probability one and the regulator in the foreign country rescues with probability zero. Equivalently, in case of a low c_i and a high c_j , the regulator in the foreign country rescues with probability one, whereas the regulator in the domestic country liquidates with probability one.

In contrast to the scenario "high protection possibility", the equilibrium (L, L) is not always Pareto efficient which leaves room for the implementation of a multinational regulator. If this equilibrium is obtained, i.e. $c_j < \tilde{c}_j^{crit}$ and $c_i < \tilde{c}_i^{crit}$, Pareto improvements are possible if $(1 - \eta)H > \frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{Hc_i - \frac{1}{c_jH}}$ and $(1 - \eta)H > \frac{H(c_j - 1) + \frac{1}{c_i}(c_i - 1)}{c_jH - \frac{1}{Hc_i}}$. Remember that these inequations are fulfilled if $c_i > \hat{c}_i^{crit}$ and $c_j > \hat{c}_j^{crit}$. To summarize, pareto improvements are possible if $\hat{c}_i^{crit} < c_i < \tilde{c}_i^{crit}$ and $\hat{c}_j^{crit} < c_j < \tilde{c}_j^{crit}$. Note that $\hat{c}_i^{crit} < \tilde{c}_i^{crit}$ and $\hat{c}_j^{crit} < \tilde{c}_j^{crit}$ are fulfilled if $c_i > 0$ and $c_j > 0$.

As a result, the implementation of a multinational regulator can improve welfare if contagion is intermediate. In this case, higher monitoring efforts can be obtained by the announcement that both banks are rescued in emergency. However, the Pareto improvement is only possible in case of medium protection possibilities. Therefore, the allocation of resolution

⁵Concerning the second derivative, we have to show that $3H^4c^2 - 6H^3c^2 - 3H^3c\eta + 3H^3c + 3H^2c^2 + 3H^2c\eta - 6H^2c + H^2\eta^2 - 2H^2\eta + 3Hc + 2H\eta + H^2 - 2H + 1 > 0$, which is equivalent to $3Hc((H-1)^2Hc + (H-1)^2) + H^2\eta^2 + 2H\eta(1-H) + 3H^2c\eta(1-H) + (H-1)^2 > 0$. This is always fulfilled.

powers to a multinational regulator may rather be supported by countries of medium budget.

4.6 Discussion

4.6.1 Variation in the number of systemic banks

We now return to the symmetric case and assume that the number of banks is given by: $n > 2$. In order to simplify our analysis, contagion either applies to all banks or to none of them. For example, if two banks fail, the probability that the other banks are hit by this failure is equal to c . The same is true if three banks fail and so on. Then bank i 's probability of survival can be written as:

$$s_i(q_i, q_{-i}) = q_i q_{-i}^{n-1} + q_i (1 - q_{-i}^{n-1}) ((1 - c) + c\beta) + (1 - q_i) \eta\beta.$$

The first term, $q_i q_{-i}^{n-1}$, is the probability that bank i and its neighbours are successful. The second term is the probability that bank i is successful and at least one of its neighbouring banks fails. Notice that the probability for the failure of at least one bank is equal to one minus the probability that all neighbouring banks are successful, i.e. $1 - q_{-i}^{n-1}$. By assumption, with probability $1 - c$, none of the failing neighbours causes contagion, whereas with probability c contagion occurs and causes the failure of bank i , unless the regulator intervenes and rescues. The last term is the probability that bank i fails, independent of its neighbours' success.

Following these assumptions, bank i 's maximization problem can be written as:

$$\max_{q_i, r_i} \left[(q_i q_{-i}^{n-1} + q_i (1 - q_{-i}^{n-1}) ((1 - c) + c\beta) + (1 - q_i) \eta\beta) (R - 1) - \frac{1}{2} \lambda q_i^2 \right],$$

where the first-order condition is equal to:

$$(q_{-i}^{n-1} + (1 - q_{-i}^{n-1}) ((1 - c) + c\beta) - \eta\beta) (R - 1) = \lambda q_i.$$

Since we assume $q_i = q_{-i}$ in equilibrium, we can rewrite this condition as:

$$(q_i^{n-1} + (1 - q_i^{n-1}) ((1 - c) + c\beta) - \eta\beta) (R - 1) = \lambda q_i.$$

For $n \mapsto \infty$, the probability that all neighbouring banks are successful, i.e. q_i^{n-1} , converges towards zero. If $q_i^{n-1} = 0$, we obtain the following effort level in equilibrium:

$$q_i^N = q_{-i}^N = \frac{1 - c + \beta(c - \eta)(R - 1)}{\lambda}.$$

Accordingly, for a sufficiently high number of banks, the bank's monitoring effort increases in β if $c > \eta$.

4.6.2 Introduction of a bank levy

We remain within the symmetric case with regard to the contagion probabilities, i.e. $c_i = c_j = c$. Assume that each bank has to pay a levy θ , which is linear in the contagion probability and which reduces the net payoff. Then bank i 's maximization problem can be described as:

$$\max_{q_i} \left[(q_i q_j + q_i (1 - q_j) (1 - c + c\beta) + (1 - q_i) \eta \beta) (R - 1 - \theta c) - \frac{1}{2} \lambda q_i^2 \right]$$

and equivalently, the maximization problem of bank j is given by:

$$\max_{q_j} \left[(q_j q_i + q_j (1 - q_i) (1 - c + c\beta) + (1 - q_j) \eta \beta) (R - 1 - \theta c) - \frac{1}{2} \lambda q_j^2 \right].$$

To ensure that each bank receives a positive net payoff in case of success, we set $\theta < R - 1$. Accordingly, even if the contagion probability is given by $c = 1$, banks receive a positive net payoff.

Then the reaction functions are given by:

$$q_i^R = (q_j + (1 - q_j) (1 - c + c\beta) - \eta \beta) \frac{(R - 1 - \theta c)}{\lambda}$$

and

$$q_j^R = (q_i + (1 - q_i) (1 - c + c\beta) - \eta \beta) \frac{(R - 1 - \theta c)}{\lambda}.$$

As a result, in equilibrium the banks choose the following effort levels:

$$q_i^N = \frac{P}{\lambda - Pc(1 - \beta)} (1 - c + c\beta - \beta \eta) = q_j^N,$$

where

$$P := R - 1 - \theta c.$$

Proposition 16 *The efficient bailout policy is given by $\beta = 1$ if*

$$c_1 < c < c_2,$$

where

$$c_1 := \frac{R - 1}{\theta}$$

and

$$c_2 := \frac{-((R - 1)(\eta - 1) + \lambda) + \sqrt{((R - 1)(\eta - 1) + \lambda)^2 + 4\eta\lambda\theta(1 - \eta)}}{2\theta(1 - \eta)}.$$

Proof. The proof is provided in the appendix. ■

Interestingly, a higher bailout only leads to a higher effort level in case of intermediate contagion probability. We already know from Section 4.4.1 that if c is sufficiently small, the

moral hazard effect dominates and therefore the regulator should liquidate with probability one. By contrast, if $c_2 > c > c_1$, contagion is sufficiently severe and a higher bailout probability leads to a higher effort level. However, if c increases, it lowers the payoff in case of survival. Due to limited liability, this induces moral hazard and therefore the regulator should liquidate with probability one if $c > c_2$. As a result, the implementation of a bank levy can reinforce the "too big to fail" problem. In the absence of any levy (or if the levy does not depend on the systemic relevance), sufficiently relevant institutions can be rescued with probability one without inducing moral hazard.

4.7 Conclusion

We determined the optimal bailout policy for a regulator who tries to prevent banks from taking excessive risks and who can credibly commit himself to his ex ante announced policy. The key ingredient of the model is the assumption that the failure of one bank can lead to the failure of another bank. The regulator can avoid such spill-over-effects, though at the cost of a subsidy for the failed bank.

Our findings suggest that a regulator can rescue banks with probability one without causing moral hazard if the probability of contagion is sufficiently large. If the systemic relevance differs among the banks, the regulator may face a conflict of interests. A relatively high systemic relevance of bank i should involve a bailout in order to increase the monitoring effort of bank j and a liquidation in order to increase the effort level of bank i . This result reveals some interesting insights, particularly with regard to the feasibility of international cooperation. Cooperation between national authorities may not only fail because of disagreement with regard to cost sharings of international public bank bailouts, but also with regard to the question of who should be rescued (liquidated).

The requirements of a bank levy can cause another problem. While in the absence of any levy the bailout of systemically relevant banks may even reduce their risk-taking, a bank levy reduces the range where bailouts are beneficial and may increase the risk incentives of banks which are perceived as being "too big to fail".

The present paper builds upon various assumptions, and it might be worthwhile to examine how crucial they are. Firstly, we assumed a special quadratic cost function which simplifies the analysis. If the cost function was linear, we would obtain corner solutions. If the cost function was of higher order, we might obtain multiple equilibria. This could be an interesting extension of the model. Secondly, we argued that a bailed out bank receives some surplus (subsidy). As long as the survival of the bank has a positive value for the shareholders, this surplus (subsidy) can be justified. Thirdly, we assumed that asset returns are not correlated. Positive correlation means that the positive effect of a bailout becomes relatively smaller because the probability that one bank is successful while the other fails decreases. This might increase the critical value for the contagion probability. In the case of perfect positive correlation, only the moral-hazard-effect remains and a higher bailout policy increases banks' risk-taking.

Apart from that, it might be interesting to examine whether a bank levy can avoid a conflict of interests between two asymmetric banks and thus increase the range where cooperation between national regulators may be feasible and desirable. We leave this question for further research.

Nevertheless the findings reveal some insights into the effects and design of an efficient bailout policy. First, the bailout of an insolvent bank can give incentives to banks to increase their monitoring efforts. Second, cooperation agreements may be difficult to establish. The Single Resolution Mechanism may be a step into the right direction, as it aims to coordinate and to facilitate resolutions. Nevertheless, the competent resolution authority and the colleges may still face a conflict of interests when deciding whether to support a failing institution, for instance, if a bail-in is not sufficient or not successful. However, globally systemic banks operate beyond the sphere of the EMU and, therefore, cooperation agreements are still necessary. Due to conflicting interests which may arise in a crisis scenario, it is doubtful whether such agreements are stable, especially when it comes to the point where regulators have to decide about supporting a failing institution or liquidating it. The awareness of such conflicts could be useful to design agreements that are not "cheap talk".

Appendix

Proof of Proposition 12

The differential of q_i^N , where

$$q_i^N = \frac{(1 - c(1 - \beta) - \beta\eta)(R - 1)}{\lambda - c(1 - \beta)(R - 1)}$$

with respect to β is given by:

$$\frac{\partial q_i^N}{\partial \beta} = \frac{(c - \eta)(R - 1)(\lambda - c(1 - \beta)(R - 1)) - (1 - c(1 - \beta) - \beta\eta)(R - 1)^2 c}{(\lambda - c(1 - \beta)(R - 1))^2}$$

which is positive if

$$c > \frac{\eta\lambda}{\lambda + \eta(R - 1) - (R - 1)} =: c^{crit}.$$

Proof of Proposition 13

The reaction functions are as follows:

$$q_i^R(q_j) = (q_j + (1 - q_j)((1 - c_j) + c_j\beta) - \eta\beta)H$$

and

$$q_j^R(q_i) = (q_i + (1 - q_i)((1 - c_i) + c_i\beta) - \eta\beta)H.$$

If $\beta = 0$, the reaction functions are:

$$q_i^R(q_j) = (q_j + (1 - q_j)(1 - c_j))H$$

and

$$q_j^R(q_i) = (q_i + (1 - q_i)(1 - c_i))H.$$

Consequently, the effort levels in equilibrium are given by (insertion of q_j^R in q_i^R):

$$q_i = ((q_i + (1 - q_i)(1 - c_i))H + (1 - (q_i + (1 - q_i)(1 - c_i))H)(1 - c_j))H$$

which can be rearranged to:

$$\frac{q_i}{H} = (q_i + (1 - q_i)(1 - c_i))H + (1 - (q_i + (1 - q_i)(1 - c_i))H)(1 - c_j)$$

and

$$\begin{aligned} & \frac{q_i}{H^2} - q_i + q_i - q_i c_i + q_i - q_i c_j - q_i(1 - c_i) + q_i(1 - c_i)c_j \\ &= (1 - c_i) + \frac{1}{H}(1 - c_j) - (1 - c_i)(1 - c_j). \end{aligned}$$

This is equivalent to:

$$\frac{q_i}{H^2} - q_i c_j c_i = \frac{1}{H} (1 - c_j) + c_j - c_i c_j.$$

Finally, the effort level in equilibrium is given by:

$$q_i = \frac{\frac{1}{H} (1 - c_j) + c_j - c_i c_j}{\left[\frac{1}{H^2} - c_j c_i \right]} =: q_i^N,$$

or, equivalently, by:

$$q_i = \frac{H}{1 - H^2 c_j c_i} (1 - c_j + H c_j - H c_i c_j) =: q_i^N.$$

Since i and j are symmetric, the effort level of j in equilibrium is:

$$q_j^N = \frac{H}{1 - H^2 c_j c_i} (1 - c_i + H c_i - H c_i c_j)$$

If $\beta = 1$, the reaction functions are:

$$q_i^R(q_j) = (1 - \eta) H$$

and

$$q_j^R(q_i) = (1 - \eta) H.$$

Therefore, the effort levels in equilibrium are:

$$q_i^N = (1 - \eta) H$$

and

$$q_j^N = (1 - \eta) H.$$

Hence, the regulator should rescue bank i and j with probability one if

$$(1 - \eta) H > \frac{H}{1 - H^2 c_j c_i} (1 - c_j + H c_j - H c_i c_j),$$

and

$$(1 - \eta) H > \frac{H}{1 - H^2 c_j c_i} (1 - c_i + H c_i - H c_i c_j).$$

Remember that $H < 1$ by assumption. This leads us to:

$$(1 - \eta) (1 - H^2 c_j c_i) > (1 - c_j + H c_j - H c_i c_j)$$

which is equivalent to:

$$c_j (1 - H^2 c_i (1 - \eta) + H c_i - H) > \eta,$$

and

$$(1 - \eta) (1 - H^2 c_j c_i) > (1 - c_i + H c_i - H c_i c_j),$$

which is equivalent to:

$$c_i (1 - H^2 c_j (1 - \eta) + H c_j - H) > \eta.$$

Notice that since $\eta > 0$, the inequations can only be fulfilled if $1 - H^2 c_i (1 - \eta) + H c_i - H > 0$ and $1 - H^2 c_j (1 - \eta) + H c_j - H > 0$. Otherwise the regulator should always liquidate. As a result, the regulator should only rescue both banks if

$$c_j > \frac{\eta}{(1 - H^2 c_i (1 - \eta) + H c_i - H)}$$

and

$$c_i > \frac{\eta}{(1 - H^2 c_j (1 - \eta) + H c_j - H)}.$$

Determination of effort levels in equilibrium (Scenario 4.5.1)

The reaction functions in the first scenario are given by:

$$q_i^R = (q_j + (1 - q_j) (1 - c_j + c_j (\beta_j + \beta_i - \beta_j \beta_i)) - \eta \beta_i) H$$

and

$$q_j^R = (q_i + (1 - q_i) (1 - c_i + c_i (\beta_j + \beta_i - \beta_j \beta_i)) - \eta \beta_j) H.$$

The payoffs for the banks in the case of the strategy combinations (R, R) , (R, L) and (L, R) are as follows:

Consider the strategy combination (L, L) . Then the reaction functions are equal to:

$$q_i^R = (q_j + (1 - q_j) (1 - c_j)) H$$

and

$$q_j^R = (q_i + (1 - q_i) (1 - c_i)) H.$$

These reaction functions are equivalent to:

$$q_i^R = (1 - c_j (1 - q_j)) H$$

and

$$q_j^R = (1 - c_i (1 - q_i)) H.$$

Hence, bank i 's effort level in equilibrium is given by:

$$q_i^N = (1 - c_j (1 - (1 - c_i (1 - q_i^N)) H)) H$$

or equivalently by:

$$q_i^N = \frac{H - c_j H + c_j H^2 - c_j c_i H^2}{(1 - c_j c_i H^2)}.$$

Rearrangements lead to:

$$q_i^N = -\frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{\frac{1}{c_j H} - H c_i}.$$

Since bank i and j are symmetric and both are liquidated in case of emergency, we can easily identify j 's effort level in equilibrium which is given by:

$$q_j^N = -\frac{H(c_j - 1) + \frac{1}{c_i}(c_i - 1)}{\frac{1}{H c_i} - c_j H}.$$

Support for the proof of Proposition 14

We show that $c_i > \widehat{c}_i^{crit}$ is equivalent to:

$$(1 - \eta) H > \frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{H c_i - \frac{1}{c_j H}}.$$

Remember that $H < 1$. Therefore, $H c_i - \frac{1}{c_j H} < 0$. Rearrangements lead to:

$$(1 - \eta) H \left[H c_i - \frac{1}{c_j H} \right] < H(c_i - 1) + \frac{1}{c_j}(c_j - 1).$$

This is equivalent to:

$$(1 - \eta) H [H^2 c_i c_j - 1] < c_j H^2 (c_i - 1) + c_j H \frac{1}{c_j} (c_j - 1)$$

and

$$(1 - \eta) H [H^2 c_i c_j - 1] < c_j H^2 (c_i - 1) + H(c_j - 1)$$

and

$$\frac{\eta + c_j H - c_j}{c_j H (1 - (1 - \eta) H)} < c_i.$$

Determination of effort levels in equilibrium (Scenario 4.5.2)

In this scenario, the reaction functions are given by:

$$q_i^R = (q_j + (1 - q_j)(1 - c_j + c_j \beta_j) - \eta \beta_i) H$$

and by:

$$q_j^R = (q_i + (1 - q_i)(1 - c_i + c_i \beta_i) - \eta \beta_j) H.$$

The payoffs for the banks in the case of the strategy combination (R, R) can be determined

easily.

For the payoffs in the other strategy combinations, consider first the strategy combination (L, L) . In this case, the reaction functions are given by:

$$q_i^R = (q_j + (1 - q_j)(1 - c_j)) H$$

for bank i and by:

$$q_j^R = (q_i + (1 - q_i)(1 - c_i)) H$$

for bank j . These reaction functions are equal to the reaction functions in the first scenario for the same strategy combination. Hence, the effort levels in equilibrium are:

$$q_i^N = -\frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{\frac{1}{c_j H} - H c_i}$$

and

$$q_j^N = -\frac{H(c_j - 1) + \frac{1}{c_i}(c_i - 1)}{\frac{1}{H c_i} - c_j H}.$$

Second, consider the strategy combination (R, L) . Then the reaction functions are given by:

$$q_i^R = (q_j + (1 - q_j)(1 - c_j) - \eta) H$$

and

$$q_j^R = H.$$

Consequently, the effort levels in equilibrium amount to:

$$q_i^N = (H + (1 - H)(1 - c_j) - \eta) H$$

for bank i and

$$q_j^N = H$$

for bank j .

The symmetry allows us to identify the payoffs in the case of the strategy combination (L, R) very easily. We obtain the following effort levels in equilibrium:

$$q_i^N = H$$

for bank i and

$$q_j^N = (H + (1 - H)(1 - c_i) - \eta) H$$

for bank j .

Support for the proof of Proposition 15

We show that $c_i > \tilde{c}_i^{crit}$ is equivalent to:

$$(H + (1 - H)(1 - c_j) - \eta)H > \frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{Hc_i - \frac{1}{c_jH}}.$$

Remember that $H < 1$. Rearrangements lead to:

$$(H + (1 - H)(1 - c_j) - \eta)H > \frac{H(c_i - 1) + \frac{1}{c_j}(c_j - 1)}{Hc_i - \frac{1}{c_jH}}$$

and

$$(H + (1 - H)(1 - c_j) - \eta)H^2c_j + \eta < c_jHc_i.$$

Further simplifications lead to:

$$\frac{\eta}{(c_jH - (H + (1 - H)(1 - c_j) - \eta)H^2c_j)} < c_i$$

and

$$\frac{\eta}{c_jH(1 + \eta H - H^2c_j + c_jH - H)} < c_i.$$

Proof of Proposition 16

By differentiating q_i^N with respect to β , we obtain:

$$\frac{\partial q_i^N}{\partial \beta} = \frac{P}{(\lambda - Pc + Pc\beta)^2} (c\lambda - \lambda\eta - cP(1 - \eta)).$$

As a result, the regulator should rescue the banks with probability one if

$$P(c\lambda - \lambda\eta - cP(1 - \eta)) > 0.$$

To solve this inequation, we first determine the solution of c if the left term of the inequation is equal to zero. Then we obtain:

$$c_1 = \frac{R - 1}{\theta}$$

and it remains to solve

$$c\lambda - \lambda\eta - c(R - 1 - \theta c) + (R - 1 - \theta c)c\eta = 0,$$

which is equal to:

$$\theta c^2(1 - \eta) + c((R - 1)(\eta - 1) + \lambda) - \lambda\eta = 0.$$

The results to this equation are given by:

$$c_2 = \frac{-((R-1)(\eta-1) + \lambda) + \sqrt{((R-1)(\eta-1) + \lambda)^2 + 4\eta\lambda\theta(1-\eta)}}{2\theta(1-\eta)}$$

and

$$c_3 = \frac{-((R-1)(\eta-1) + \lambda) - \sqrt{((R-1)(\eta-1) + \lambda)^2 + 4\eta\lambda\theta(1-\eta)}}{2\theta(1-\eta)}.$$

We know that $c_3 < 0$. Finally, we have to know whether $c_2 > c_1$. It is easy to show that this is always fulfilled. Hence, an increase of β increases the effort level if

$$c_1 < c < c_2.$$

Chapter 5

Who Should Rescue Subsidiaries of Multinational Banks?

5.1 Introduction

Cross-border banking plays an increasing role, especially within the European Union (Allen, Beck, Carletti, Lane, Schoenmaker & Wagner (2011)). In the aftermath of the recent global financial crisis, a process was initiated at the meetings of the Group of Twenty (G-20), starting with the meeting 2008 in Washington D.C. to modify bank regulation. This process led to the implementation of a Single Resolution Mechanism (SRM) in Europe. The centralization of bank regulation and resolution is supported by the implementation of a single rulebook. The Bank Recovery and Resolution Directive (BRRD) has recently been adopted. It regulates crisis prevention, early intervention and crisis resolution measures in the European Union. Resolution authorities in the Member States shall establish resolution colleges and cooperate from the crisis prevention stage, i.e. preparation of recovery and resolution plans, to the actual resolution of an institution. Such cooperations should be supported by cooperation agreements and, if necessary, by the intermediation of the European Banking Authority (EBA). The funding of resolution tools shall be achieved by financial arrangements and financed by the institutions through (at least) annual fees. This chapter presents an efficient cooperation agreement and shows how such an agreement could be implemented. While the BRRD consider the bail-in tool as a key resolution tool for banks in trouble, this chapter shall provide a rationale for bank bailouts. These may be desirable from a welfare point of view.

To address these issues, we consider a multinational bank which is located in a home country and has invested one part of its funds in a host country (abroad) through a subsidiary bank. The subsidiary bank monitors the project, which causes costs. After choosing its monitoring effort, the subsidiary bank is probably hit by a solvency shock. If this happens, the bank becomes insolvent and cannot continue to operate, unless it is rescued. This shock is supposed to be observable by the regulator and the banks, but it is not verifiable by a third party (incomplete-contract approach). Consequently, the regulator and the banks cannot sign

a contract which promises a certain bailout policy depending on the shock. Hence, neither the national nor the multinational regulator can commit themselves to an ex ante defined bailout policy, but the subsidiary bank takes the regulator's ex post incentives into account.

We consider three potential regulators who might be interested in the survival of the subsidiary bank: a home country regulator, a host country regulator, and a multinational (supranational) regulator. They decide to bail the insolvent subsidiary bank out if its liquidation value is lower than its continuation value. These values differ among the regulators for three reasons. Firstly, national regulators care only about their domestic welfare, while the multinational regulator takes aggregate welfare into consideration. Secondly, the net payoffs, generated by the subsidiary bank in case of success, are transferred to the home country (the parent bank is the unique owner of its subsidiary), i.e. they only affect the home country and the multinational regulator. Thirdly, the failure of the subsidiary bank causes systemic costs which only affect the welfare of the host country and the multinational regulator.

The subsidiary bank faces the following trade-off: A sufficiently high monitoring effort ensures that its expected continuation value exceeds its liquidation value, which, in turn, induces the regulator in charge to bail it out if the solvency shock appears. However, monitoring is costly and this decreases the subsidiary bank's expected profit.

This framework reveals the following main results:

- An internationally coordinated bank bailout is desirable as it can decrease the subsidiary bank's monitoring effort and thus reduce moral hazard (excessive risk-taking).
- National regulators should rescue the insolvent subsidiary bank in case of a sufficiently low solvency shock, whereas the multinational regulator should rescue in case of intermediate shocks. The allocation of tasks is unimportant if the solvency shock is sufficiently large.
- Without burden sharing, national regulators rely on the multinational regulator's safety net which induces the subsidiary bank to choose the lowest necessary effort level in order to be rescued.
- In order to implement the first-best allocation of tasks, the home country regulator should bear the multinational regulator's bailout costs if solvency shock is very low. In case of a low shock, the host country regulator should bear these bailout costs. If shocks are intermediate, the national regulators' contribution to the multinational regulator's bailout costs should be as small as possible. The funding of the multinational regulator's bailout costs is not important if the shock is sufficiently large.

This chapter proceeds as follows: Section 5.2 provides a short overview of the literature and Section 5.3 introduces the model. Section 5.4 derives the optimal allocation of resolution power. Section 5.5 shows how this optimal allocation can be implemented. Section 5.6 shows the bank's effort level if the bailout responsibility is allocated to the regulator and to the parent bank. Section 5.7 concludes Chapter 5.

5.2 Literature review

This paper is related to three strands of the literature. One strand determines the welfare-optimal bailout strategy for national insolvent banks. As in this model, Freixas (1999) finds that the regulator's rescue decision is determined by bailout costs and liquidation costs. If bailout costs are sufficiently higher than liquidation costs, the regulator should apply "constructive ambiguity", i.e. he should bail the bank out with probability strictly between zero and one. Otherwise, he should always rescue the bank with probability one.

Cordella & Yeyati (2003) analyse the optimal bailout strategy for an insolvent bank in a dynamic framework where the bank's probability of survival depends on macroeconomic conditions which are outside the sphere of influence of the bank. The optimal bailout policy is to rescue the bank in times of macroeconomic distortions and to liquidate it otherwise. On the one hand, a higher bailout probability raises the value of the bank and thus lowers its gambling incentives (value effect). On the other hand, a higher bailout probability reduces the impact of the bank's risk decision on the probability of its survival, which induces the bank to increase its risk level (moral-hazard-effect). If the value effect outweighs the moral-hazard-effect, bailout with probability one is the regulator's optimal choice. Otherwise the bank should be liquidated with probability one. As in Cordella & Yeyati (2003), we account for such macroeconomic conditions and assume that the subsidiary bank is hit by a solvency shock with an exogenous determined probability.

A second strand deals with regulation in cross-border banking. Acharya (2003) shows that harmonization of closure policies has to be linked to harmonization of capital controls. He argues that banks in more forbearing countries choose higher risks than banks in less forbearing countries, which reduces the charter value of the latter ones. In order to avoid the exit of banks in less forbearing countries, central banks in these countries have to adopt the same policy as central banks in more forbearing countries, which induces a race to the bottom. Dell'Ariccia & Marquez (2006) show that competition between national regulators can lead to suboptimally low standards. However, they argue that a centralized regulator has disadvantages, too, as he is less flexible. Loranth & Morrison (2007) analyse the effects of capital requirements for cross-border banks. They provide evidence that a capital requirement, which is optimal for a national bank, results in under-investment when it is applied to multinational banks. However, a uniform regulation of capital requirement brings about disadvantages to multinational banks which are invested abroad through branches and favours subsidiary bank structures (Dietrich & Vollmer (2010)). By contrast to these authors, we focus on bank bailouts as the regulatory tool and do not account for the welfare effects of capital requirements.

Calzolari & Loranth (2011) analyse a national regulator's incentive to intervene in multinational banks where the incentive depends on whether the bank is represented through a subsidiary or a branch bank. They show that shared liability, i.e. branch banking, induces higher incentives to intervene. Beck et al. (2011) argue that cross-border activities can disturb the domestic regulator's incentives to intervene, and the implementation of a multinational

regulator might be beneficial from a welfare point of view. Espinosa-Vega et al. (2011) consider regulatory agencies' forbearance and information sharing incentives. They show that regulators might be more forbearing towards systemically important institutions. When some regulators have access to information concerning the degree of systemic relevance of an institution, they have few incentives to share this information with other regulators. Huizinga et al. (2011) provide evidence that internationally active banks have a disadvantage compared to national banks since they receive less implicit subsidies from the safety net. This results in higher funding costs for multinational banks and therefore national safety nets might create a burden to the internationalization of banks.

We do not model the multinational bank's incentives to go abroad, but assume that it has already invested in a foreign country through a subsidiary bank. By contrast to Beck et al. (2011), we assume that the subsidiary operating in the foreign market is only funded by insured deposits. As in the model of Espinosa-Vega et al. (2011), we focus on the interaction between different regulators, though we neither restrict our attention to systemic banks nor do we assume that the national and the multinational regulators have different information about the failed bank. We rather derive the optimal allocation of bank bailouts between a national host country and a multinational regulator and show why burden sharing is necessary in order to achieve this allocation of tasks.

A third strand determines the optimal allocation of regulatory power. Mikkonen (2006) shows that ambiguity between liquidity provision by a central bank and by a national regulator can be welfare-improving. Similarly, we derive the optimal allocation of regulatory power between a national and a multinational regulator, but, in contrast to Mikkonen (2006), we also account for a home country regulator. The models of Repullo (2000) and Kahn & Santos (2005) are close to ours. Repullo (2000) finds that in case of a small liquidity shock, the regulation should be allocated to the central bank, whereas in the case of high solvency shocks the deposit insurance should provide liquidity assistance. Kahn & Santos (2005) argue that it depends on the liquidity shock level whether centralizing the power of a lender of last resort and a deposit insurance is desirable. While the decentralization of the power is beneficial in case of high liquidity shocks, it might be undesirable in case of low liquidity shocks. In contrast to Repullo (2000) and Kahn & Santos (2005), we do not restrict our attention to the regulators' incentives, but account for the subsidiary bank's maximization problem. As we do in our model, Niepmann & Schmidt-Eisenlohr (2013) find that the implementation of a multinational regulator can be welfare-improving if he also has fiscal power. Similarly to our findings, Goodhart & Schoenmaker (2009) show that ex ante burden sharing of bank bailouts can be welfare-efficient, especially when burden is shared between countries which are directly affected by the failure of an institution. By contrast to Niepmann & Schmidt-Eisenlohr (2013) and Goodhart & Schoenmaker (2009), we also model a potentially bailed out bank's risk incentives depending on who rescues and justify the optimal allocation of tasks and burden sharing arrangement from a moral-hazard point of view.

5.3 The model

5.3.1 Players and action sets

Consider the following risk-neutral players: a regulator which can be either multinational or national, a multinational bank which has invested in a host country through a subsidiary bank, and depositors. We neglect any principal-agent-problems between the parent bank and its subsidiary. Furthermore, the parent bank is the unique owner of the subsidiary bank whose profit is transferred to the home country. Therefore, the profit of the subsidiary bank does not affect the welfare of the host country, but increases the welfare of the home country.

Depositors

Depositors are fully insured. The deposit demand function is assumed to be totally elastic, offering the opportunity for the subsidiary bank to fund itself infinitely by offering at least the risk-free interest rate. We normalize the risk-free interest rate and the insurance premium, paid by the subsidiary bank, to zero.

Multinational bank and its subsidiary

The multinational bank has invested both in a foreign country through a subsidiary bank and in the home country through the parent bank. We abstract from an exchange rate risk and exclude any conflict of interest between the subsidiary and the parent bank. The investment in the home country is riskless, can be liquidated without any costs and is financed through equity capital. This ensures that the parent bank does not become insolvent and always has funds available to support the subsidiary bank if necessary. The assumption will particularly play a role in Section 5.6.

By contrast, the foreign investment through the subsidiary is risky. Its liquidation causes liquidation costs, which are supposed to be one, and it is solely financed by secured deposits. We assume that the liability of the subsidiary bank is one, which is equal to the payoff to the depositors, as the deposit rate is zero. The investment generates a payoff (henceforth we often write "return") of $R \in (1, 2)$ with probability $q \in [0, 1]$ and 0 with probability $1 - q$. Hence, the return function \tilde{R} of the subsidiary bank is given by:

$$\tilde{R} = \begin{cases} R & \text{with probability } q \\ 0 & \text{with probability } 1 - q \end{cases}.$$

Due to the assumption that the investment is totally financed by deposits, the subsidiary bank is insolvent if the project fails. The parent bank (or the subsidiary bank) can influence q by monitoring the foreign investment. The monitoring effort is equal to the probability of success

q and its cost is given by $c(q) = \frac{1}{2}\phi q^2$, where $\phi > 0$ measures the inefficiency of the bank.

After choosing the monitoring effort, which is the bank's private information, the subsidiary bank experiences a solvency shock $v \in [0, 1]$ with probability $1 - \lambda$, where $\lambda \in [0, 1]$. All players can observe v , but it cannot be verified by a third party. We assume that only the risky investment can be affected by the solvency shock, and if the shock appears, the subsidiary bank has to write-off v of the initial project value. As the subsidiary bank is solely financed by debt, it is (then) insolvent and cannot continue to operate unless rescued by a regulator. In order to guarantee the continuation of the project, the parent bank or the regulator has to inject v . Assume, for instance, that the subsidiary lent to a corporation that has to depreciate a part of its assets and cannot continue with its initial project unless it receives further funds from the bank. We argue that an insolvent bank cannot fund itself via the capital market and, therefore, the subsidiary bank itself cannot raise funds in order to guarantee its continuation. Capital injection does not increase the initial value, but it solely guarantees the continuation of the initial project.

The subsidiary bank does not have to repay bailout costs. Following these assumptions, the subsidiary bank's profit function is given by:

$$\pi = \begin{cases} \pi^R := q[R - 1] - \frac{1}{2}\phi q^2; & \text{if bailed out} \\ \pi^L := \lambda q[R - 1] - \frac{1}{2}\phi q^2; & \text{if liquidated} \end{cases},$$

where index R stands for "rescued" and index L for "liquidated". Notice that the probability for a solvency shock does not matter in the profit function of a bank which will be bailed out in emergency because it will always survive the shock.

Regulators

The incentive to bail the subsidiary bank out varies among regulators. The national regulators take their domestic welfare into account whereas the multinational regulator accounts for the aggregate welfare (sum of national welfare). As depositors are located in the host country, their wealth only influences the welfare in that country. Shareholders are located in the home country and therefore, their wealth (subsidiary bank's net profit) only affects the welfare in the home country.

The liquidation of the subsidiary bank or/and the failure of the project causes costs C_F (index " F " stands for failure). These failure costs can, for instance, be interpreted as systemic (contagion) costs. The liquidation value of the insolvent subsidiary bank is supposed to be zero. Hence, if the subsidiary bank is liquidated, the payoff to the host country is $-[1 + C_F]$ because depositors lose their initial wealth and the host country regulator has to bear the failure costs. Liquidation does not affect the welfare in the home country.

In case of a bailout, the welfare loss of the host country regulator is equal to the difference

Figure 5.1: Payoffs of the regulators

| | Liquidation value | Continuation value (bailout) |
|---------------|-------------------|------------------------------------|
| Home | 0 | $-v + q[R - 1]$ |
| Host | $-[1 + C_F]$ | $-v - [1 - q][C_F + 1]$ |
| Multinational | $-[1 + C_F]$ | $-v + q[R - 1] - [1 - q][C_F + 1]$ |

between capital injection v , expected failure costs $[1 - q]C_F$, and expected loss of depositors' wealth, i.e. $[1 - q]$. The home country regulator does not care about expected failure costs, but about the subsidiary bank's profit and therefore his welfare equals the difference between expected net payoff of the project, $q[R - 1]$, and capital injection v .

The multinational regulator's payoff is the sum of the payoffs of the host country regulator and the home country regulator, except for the required capital injection, which is always given by v . Notice that the multinational and the home country regulator take the monitoring costs of the subsidiary bank into consideration, but these costs do not influence their decision since these costs affect the payoff in both scenarios (bailout and liquidation).

Regulators, be they national or multinational, only intervene if the shock occurs. Then they decide to rescue the subsidiary bank if the liquidation value is lower than the continuation value. Figure 5.1 summarizes the payoffs of the home, the host and the multinational regulator under the assumption that only one of the regulators is in charge.

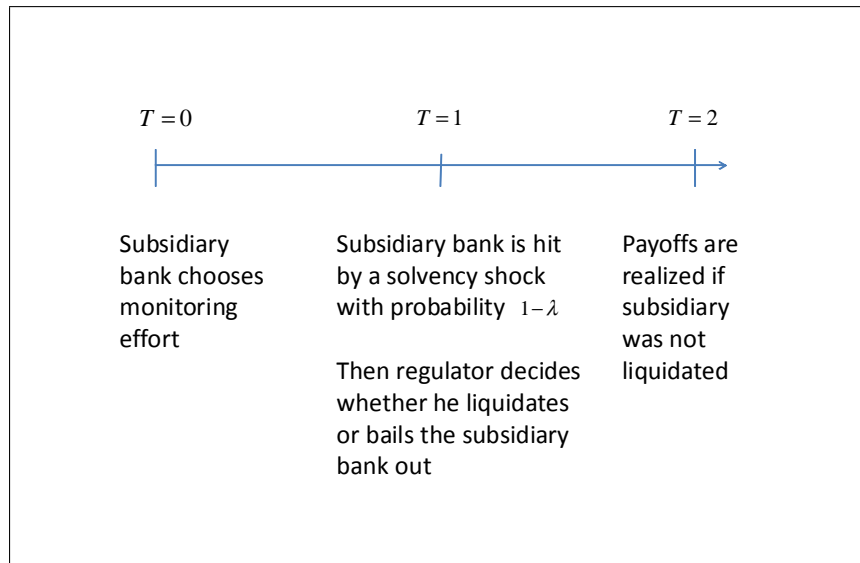
5.3.2 Sequence of events

The time horizon extends over two periods. We neglect any time preference. The timing of the game is as illustrated in Figure 5.2. First, the subsidiary bank chooses its monitoring effort. Second, a solvency shock appears with probability $1 - \lambda$. If the subsidiary bank is hit by the solvency shock, it can ask for a bailout, i.e. capital injection v , and the regulator has to decide whether to bail the subsidiary out or to liquidate it. In the case of being bailed out, the subsidiary generates the payoff R with probability q and with probability $1 - q$ it fails. If the subsidiary bank is liquidated, depositors are paid by the regulator and the subsidiary bank's project cannot be terminated. Third, the subsidiary bank realizes payoffs, unless it has been liquidated.

5.3.3 Equilibrium concept

We concentrate on subgame perfect equilibria. Therefore, we apply backward induction beginning with the regulators' decision at the second stage of the game. Taking their decision into account, we determine the bank's optimal decision at the first stage of the game.

Figure 5.2: Sequence of events



5.4 Optimal allocation of resolution power between national regulators and a multinational regulator

We initially assume that the parent bank cannot afford a bailout or is not willing to rescue its subsidiary, which means that the subsidiary bank can only be rescued by either the national (host or home country regulator) or the multinational regulator. We will consider a potential bailout by the parent bank in Section 5.6. The game is solved by backward induction beginning with the second stage where the regulators decide whether to bail the subsidiary bank out or to liquidate it.

5.4.1 Bailout decisions of the regulators

The host country regulator bails the subsidiary bank out if the continuation value exceeds the liquidation value, i.e. if (the index "H" stands for "host" country regulator)

$$q \geq \frac{v}{C_F + 1} =: q^H,$$

where $q^H \leq 1$ by $v \leq 1$. The threshold level q^H increases in v and decreases in C_F . Intuitively, a higher v , i.e. the more capital is needed to ensure the continuation of the project, has to be compensated by a higher probability of project success in order to induce the regulator to rescue. An increase of failure costs C_F decreases the liquidation value and therefore the host country regulator accepts a lower monitoring effort. The host country regulator faces the following trade-off: Liquidating the subsidiary bank avoids capital injection v , but it disclaims the part of the assets that were not hit by the solvency shock, i.e. $1 - v$, and causes failure costs with probability one instead of probability $1 - q$. Hence, if he liquidates the subsidiary

bank, welfare loss is $C_F + 1$ with certainty, whereas in case of a bailout, welfare loss is $v < 1$ with certainty and $C_F + 1$ with probability $1 - q$.

The home country regulator rescues the subsidiary bank if (the index "NH" stands for "native" country, i.e. "home" country regulator)

$$q \geq \frac{v}{R - 1} =: q^{NH}.$$

An increase of v raises the required monitoring effort q^{NH} , whereas an increase of R decreases q^{NH} . Intuitively, an increase of R raises the payoff of the project and, therefore, the benefits from a bailout. The home country regulator faces the following trade-off: Liquidating the subsidiary bank avoids capital injection v , but it disclaims the payoff R of the project.

The multinational regulator bails the subsidiary bank out if (the index "M" stands for "multinational" regulator)

$$q \geq \frac{v}{R + C_F} =: q^M.$$

The threshold q^M increases in v and decreases in R and C_F . As the host country regulator, the multinational regulator also accounts for the failure costs. However, the multinational regulator also takes the payoff R into consideration. He faces the following trade-off. Liquidating the subsidiary bank avoids the capital injection v , but it disclaims the payoff of the project and the part of the assets that were not hit by the solvency shock, i.e. $1 - v$.

We immediately see that $q^{NH} > q^H > q^M$. Figure 5.3 illustrates the regulators' bailout decision, depending on the subsidiary bank's monitoring effort and the solvency shock if we assume that only one regulator exists. A higher solvency shock requires a higher monitoring effort, thus a higher probability of success for the project. The reason is that a higher shock level, v , increases the bailout costs which have to be outweighed by an increase of the expected project payoff, qR , or/and by a decrease of expected failure costs, $[1 - q]C_F$. The marginal increase of q^H is higher than q^M because the host country regulator does not benefit from an increase of expected project payoff, qR . However, it is lower than the marginal increase of q^{NH} , as he has to take failure costs into account.

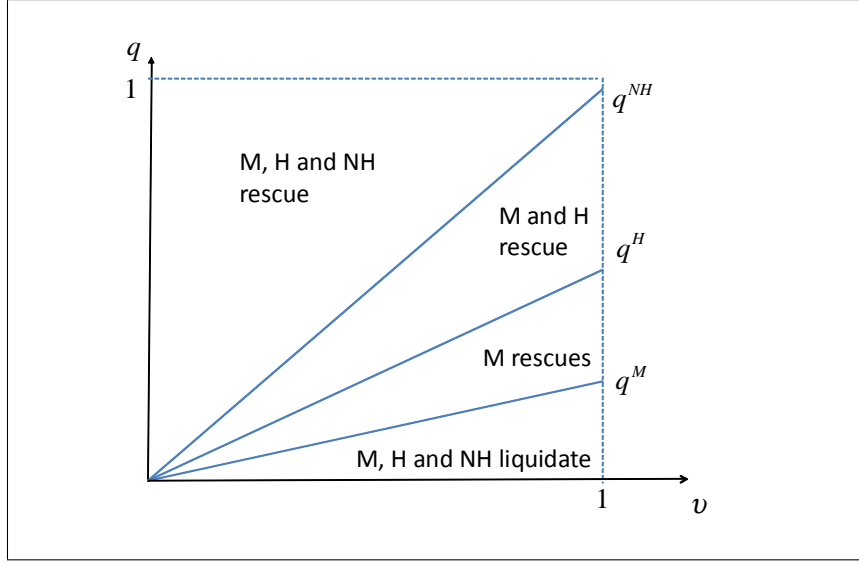
Before we determine the subsidiary bank's optimal monitoring effort at the first stage of the game, we calculate the first-best monitoring effort from an aggregate welfare point of view.

5.4.2 Welfare-optimal monitoring effort

The effort level, which a welfare-maximizing subsidiary bank chooses if only the multinational regulator exists, is defined as the first-best monitoring effort. As a welfare-maximizing bank takes the welfare of the host and the home country into account, it may be rational to consider a multinational regulator instead of a national regulator when determining the welfare-optimal monitoring effort.

We denote W as the objective function of the welfare-maximizing subsidiary bank. It is

Figure 5.3: Bailout decisions of the regulators if only one regulator is in charge



partially defined, depending on whether it is rescued or liquidated in the case of a solvency shock, and given by:

$$W = \begin{cases} W^R; & q \geq q^M \\ W^L; & q < q^M \end{cases} ,$$

where index R stands for "rescued" and index L for "liquidated". W^R is similar to the multinational regulator's payoff determining the bailout decision, but differentiates from this in two points. Firstly, we have to take the monitoring costs $c(q)$ into account. Secondly, the expected capital loss amounts to $-[1 - \lambda]v$ instead of $-v$. The failure costs and the loss of depositors' wealth, $C_F + 1$, reduce aggregate welfare if the shock appears and the project fails, i.e. with probability $[1 - \lambda][1 - q]$, and if the shock does not appear, but the project nevertheless fails, i.e. with probability $[1 - q]\lambda$. As a result, W^R is given by:

$$W^R = -[1 - \lambda]v + q[R - 1] - c(q) - [1 - q]\lambda[C_F + 1] - [1 - \lambda][1 - q][C_F + 1] ,$$

which is equivalent to:

$$W^R = -1 - [1 - \lambda]v + qR - c(q) - [1 - q]C_F, \quad (5.1)$$

where

$$q^* = \frac{1}{\phi} [R + C_F] = \arg \max_q W^R. \quad (5.2)$$

W^L differs in three points from (5.1). Firstly, the subsidiary bank only generates R if the solvency shock does not occur, i.e. with probability λ . Secondly, the costs of failure and the loss of depositors' wealth decrease welfare if the shock appears, independently of whether the project would have been successful, i.e. with probability $1 - \lambda$ and if the shock does not

appear, but project fails, i.e. with probability $\lambda[1 - q]$. Thirdly, the regulator does not have to inject v . Consequently, W^L is given by:

$$W^L = \lambda q [R - 1] - c(q) - [1 - \lambda] [C_F + 1] - \lambda [1 - q] [C_F + 1],$$

which is equivalent to:

$$W^L = -1 + \lambda q R - c(q) - [1 - q\lambda] C_F, \quad (5.3)$$

where

$$\tilde{q}^* = \frac{\lambda}{\phi} [R + C_F] = \arg \max_q W^L. \quad (5.4)$$

Proposition 17 *The aggregate welfare optimizing subsidiary bank's monitoring effort depends on the shock level v and the efficiency level ϕ in such a way that*

- if $\phi \geq R + C_F$, the welfare-optimizing subsidiary bank chooses

$$q^W = \begin{cases} q^*; & v \leq \frac{1}{2} \frac{1}{\phi} [R + C_F]^2 [1 + \lambda] =: v^{RH} \\ \tilde{q}^*; & v > v^{RH} \end{cases},$$

- if $\lambda[R + C_F] \leq \phi < R + C_F$, it chooses

$$q^W = \begin{cases} 1; & v \leq \frac{[R + C_F] - \frac{1}{2} \frac{\lambda^2}{\phi} [R + C_F]^2 - \frac{1}{2} \phi}{[1 - \lambda]} =: v^{RI} \\ \tilde{q}^*; & v > v^{RI} \end{cases},$$

- if $\phi < \lambda[R + C_F]$, it chooses

$$q^W = 1.$$

Proof. The proof is provided in the appendix. ■

The intuition is as follows. In the case of $\phi < \lambda[R + C_F]$, monitoring is relatively inexpensive due to high efficiency. Therefore the maximum monitoring effort, $q^W = 1$, is welfare-optimal. If monitoring efficiency is $\lambda[R + C_F] \leq \phi < R + C_F$, the optimal effort level depends on the solvency shock level. In case of a sufficiently low solvency shock, rescuing is better than liquidating, as rescue costs are still sufficiently small. If this is the case, then the welfare maximizing subsidiary bank chooses $q = 1$. By contrast, if the solvency shock is sufficiently large, rescuing is too costly and it is more beneficial for the subsidiary bank to gamble, i.e. to choose \tilde{q}^* . In case of sufficiently low monitoring efficiency, i.e. $\phi \geq R + C_F$, both effort levels q^* and \tilde{q}^* are lower than one, and the optimal effort level depends again on whether rescuing is rather costly, i.e. $v > v^{RH}$, or not, i.e. $v \leq v^{RH}$.

5.4.3 Monitoring effort of the subsidiary bank

Again, the subsidiary bank's objective function is partially defined. Denoting $\pi = \pi^R$ as the bank's profit if $q \geq q^{RE}$ (index "RE" stands for "regulator", i.e. for H , NH and M), where q^{RE} is the threshold (Section 5.4.1) of the regulator in charge, and $\pi = \pi^L$ as the subsidiary bank's profit if $q < q^{RE}$, we obtain the following objective function:

$$\pi = \begin{cases} \pi^R; & q \geq q^{RE} \\ \pi^L; & q < q^{RE} \end{cases}.$$

Notice that π^R and π^L have already been defined in Section 5.3.1.

Consider π^R . Remember that in this case, we do not have to consider the probability for a solvency shock. The subsidiary bank's expected net payoff is given by $q[R - 1] - \frac{1}{2}\phi q^2$. Hence, the optimal monitoring effort of the subsidiary bank is given by (index "B" stands for "subsidiary bank"):

$$q^B := \frac{1}{\phi} [R - 1] = \arg \max_q \pi^R. \quad (5.5)$$

An increase in the project return R increases q^B because the opportunity costs of gambling increase. This means a lower probability of project success. Comparing (5.2) and (5.5), we see that $q^B < q^*$, which results because of two facts. Firstly, the subsidiary bank does not account for systemic costs of its failure, C_F . Secondly, it takes advantage of limited liability and passes part of the risk to depositors.

Consider π^L . In this case, we have to take the probability of a solvency shock into account. This means that the subsidiary bank's expected net payoff decreases to $\lambda q[R - 1] - \frac{1}{2}\phi q^2$. We obtain the following optimal monitoring effort for the subsidiary bank (the "tilde" stands for the case in which the subsidiary bank is liquidated in case of a solvency shock):

$$\tilde{q}^B := \frac{\lambda}{\phi} [R - 1] = \arg \max_q \pi^L. \quad (5.6)$$

An increase in the probability that the shock does not occur increases \tilde{q}^B . Intuitively, an increase of λ increases expected profit which, in turn, raises incentives to engage in higher monitoring.

As $\pi^R(q^B) > \pi^L(\tilde{q}^B)$, the subsidiary bank chooses q^B if it is not constrained, i.e. if $q^B \geq q^{RE}$. By contrast, if $q^B < q^{RE}$, the bank's optimal effort level depends on whether $\pi^R(q^{RE}) \geq \pi^L(\tilde{q}^B)$.

Proposition 18 *The subsidiary bank's optimal monitoring effort depends on the solvency shock in such a way that*

- if the host country regulator controls, it chooses

$$q = \begin{cases} q^B; & v < \frac{1}{\phi} [R - 1] [C_F + 1] =: \hat{v}^H \\ q^H; & \hat{v}^H \leq v \leq \frac{1}{\phi} [R - 1] [1 + C_F] \left[1 + \sqrt{1 - \lambda^2} \right] =: \tilde{v}^H \\ \tilde{q}^B; & v > \tilde{v}^H \end{cases},$$

- if the multinational regulator controls, it chooses

$$q = \begin{cases} q^B; & v < \frac{1}{\phi} [R - 1] [C_F + R] =: \hat{v}^M \\ q^M; & \hat{v}^M \leq v \leq \frac{1}{\phi} [R - 1] [R + C_F] \left[1 + \sqrt{1 - \lambda^2} \right] =: \tilde{v}^M \\ \tilde{q}^B; & v > \tilde{v}^M \end{cases},$$

- if the home country regulator controls, it chooses

$$q = \begin{cases} q^B; & v < \frac{1}{\phi} [R - 1]^2 =: \hat{v}^{NH} \\ q^{NH}; & \hat{v}^{NH} \leq v \leq \frac{1}{\phi} [R - 1]^2 \left[1 + \sqrt{1 - \lambda^2} \right] =: \tilde{v}^{NH} \\ \tilde{q}^B; & v > \tilde{v}^{NH} \end{cases}.$$

Proof. The proof can be found in the appendix! ■

The intuition is the following. We have to differentiate between three cases, independently of who is in charge. If the solvency shock is sufficiently low, the regulator's threshold level is not binding and the subsidiary bank can choose $q^B \geq q^{RE}$ without taking the risk of being liquidated. q^B , however, is not optimal if $q^B < q^{RE}$ because $\pi^L(q^B) < \pi^L(\tilde{q}^B)$. Then the subsidiary bank decides between choosing the threshold q^{RE} , which is necessary in order to be bailed out in case of a shock, and gambling, i.e. \tilde{q}^B . In case of intermediate shocks, the subsidiary bank follows the regulator's requirement and chooses q^{RE} because q^{RE} is not too high (remember that q^{RE} increases in v). By contrast, if the solvency shock is sufficiently high, q^{RE} is too costly and therefore, the subsidiary bank prefers to gamble. The thresholds \hat{v} and \tilde{v} are decreasing in ϕ . Intuitively, the higher the inefficiency of the subsidiary bank, the less it is willing to accept a monitoring effort $q^{RE} > q^B$ because of the higher monitoring costs. Finally, an increase of λ decreases \tilde{v} because the expected payoff in the gambling case increases, which raises incentives to choose \tilde{q}^B .

5.4.4 Welfare-optimal allocation of bailout responsibility

To begin with, we examine whether the regulators can be too strict, which means that the subsidiary bank follows the regulator's requirement although it is not beneficial from a welfare point of view.

Lemma 19 Consider the range for v , where the subsidiary bank chooses the regulator's thresholds $q = q^{RE}$. We have

- $W(q^M) \geq W(\tilde{q}^B)$ if

$$\hat{v}^M \leq v \leq \min \left(v_R^M := \frac{\lambda}{\phi} [R + C_F] [2[R + C_F] - [R - 1]]; \tilde{v}^M \right),$$

- $W(q^H) \geq W(\tilde{q}^B)$ if

$$\hat{v}^H \leq v \leq \tilde{v}^H,$$

- $W(q^{NH}) \geq W(\tilde{q}^B)$ if

$$\hat{v}^{NH} \leq v \leq \tilde{v}^{NH}.$$

Proof. The proof can be found in the appendix! ■

First of all, if the subsidiary bank chooses q^{RE} instead of \tilde{q}^B , q^{RE} is beneficial from a bank's point of view. However, expected bailout costs influence the aggregate welfare, too. If the shock is sufficiently low, expected bailout costs are low and rescuing the subsidiary bank, which has chosen q^H or q^{NH} , is more beneficial than liquidating the bank which chose \tilde{q}^B . Therefore, the presence of the national regulators is good from a welfare point of view if solvency shocks are such that these regulators can induce the bank to choose their required threshold level q^H and q^{NH} respectively.

By contrast, if the multinational regulator can induce the subsidiary bank to choose q^M , the shock level is relatively high. In combination with a relatively low q^M , the existence of the multinational regulator is only beneficial if the shock level is not too high, i.e. $v_R^M \leq v$.

Being aware that the existence of the regulators is (national case), or at least can be (multinational case), welfare efficient, we now ask who should be in charge.

Lemma 20 *Assume that each regulator can be in charge. Then*

- *the multinational regulator causes higher welfare than the host country regulator, $W(q^M) > W(q^H)$, if*

$$v > \frac{2}{\phi} \frac{[R + C_F]^2 [C_F + 1]}{[R + C_F] + [C_F + 1]} =: v^{MH},$$

- *the host country regulator causes higher welfare than the home country regulator, $W(q^H) > W(q^{NH})$, if*

$$v > \frac{2}{\phi} [R - 1] [C_F + 1] =: v^{HNNH},$$

where

$$v^{MH} > v^{HNNH}.$$

- *Moreover, we have $W^R(q^B) > W^L(\tilde{q}^B)$ if*

$$v < \frac{1}{\phi} [R - 1] [1 + \lambda] \left[[R + C_F] - \frac{1}{2} [R - 1] \right] =: v^C.$$

Proof. The proof can be found in the appendix! ■

Lemma 20 argues that if the subsidiary bank accepts all thresholds, i.e. q^M , q^H and q^{NH} , the multinational regulator should rescue in case of $v > v^{MH}$, the host country regulator in case of $v^{MH} > v > v^{HNNH}$ and the home country regulator in case of $v < v^{HNNH}$. Moreover, we know that rescuing the subsidiary bank, which chooses $q^B \geq q^{RE}$, is beneficial unless $v \leq v^C$. Intuitively, q^B leads to a higher probability of project success, but it also causes bailout costs. If these bailout costs are sufficiently large, i.e. $v > v^C$, it is not efficient to have a regulator who enables the subsidiary bank to choose q^B without risking to be liquidated. Taking Lemma 20, Proposition 18 and Lemma 19 into account, we can derive the optimal allocation of tasks.

Proposition 21 *The optimal allocation of tasks depends on the solvency shock in such a way that*

- *the home country regulator should be in charge if*

$$\hat{v}^{NH} \leq v \leq \tilde{v}^{NH},$$

- *the host country regulator should be in charge if*

$$\tilde{v}^{NH} < v \leq \tilde{v}^H,$$

- *the multinational regulator should be in charge if*

$$\begin{aligned} & \tilde{v}^H \leq v \leq v^C \vee \hat{v}^M \leq v \leq \min(\tilde{v}^M; v_R^M); \quad \hat{v}^M > \tilde{v}^H \wedge \tilde{v}^H < v^C < \hat{v}^M \\ & \hat{v}^M \leq v \leq \min(\tilde{v}^M; v_R^M); \quad \hat{v}^M \geq \tilde{v}^H \wedge v^C < \tilde{v}^H \\ & \tilde{v}^H \leq v \leq \min(\tilde{v}^M; v_R^M); \quad \hat{v}^M < \tilde{v}^H \vee v^C > \hat{v}^M \end{aligned},$$

where

$$v_R^M := \frac{\lambda}{\phi} [R + C_F] [2[R + C_F] - [R - 1]].$$

Proof. The proof can be found in the appendix. ■

The intuition is straightforward. If the solvency shock is lower than \hat{v}^{NH} , none of the regulators can induce the subsidiary bank to choose a higher monitoring effort than q^B because the thresholds q^M , q^H and q^{NH} are non-binding, i.e. lower than q^B . Then it does not matter who is in charge. In case of sufficiently low solvency shocks, $\hat{v}^{NH} \leq v \leq \tilde{v}^{NH}$, the home country regulator should be in charge, as he can induce the subsidiary bank to choose the highest possible monitoring effort which is desirable since bailout costs are relatively small.

If solvency shocks are beyond \tilde{v}^{NH} , the home country regulator's threshold q^{NH} is too strict and, therefore, he should pass the bailout decision to the host country regulator. The host country regulator should bail out in the case of $\tilde{v}^{NH} < v \leq \tilde{v}^H$, i.e. as long as he can induce the subsidiary bank to choose q^H instead of \tilde{q}^B . In this range, bailout costs are

still sufficiently small, so that rescuing is more beneficial than inducing the subsidiary bank to choose \tilde{q}^B .

If the shock level exceeds \tilde{v}^H , the host country regulator cannot induce the subsidiary bank to choose q^H . Whether the multinational regulator should be in charge, depends on whether he can induce the subsidiary bank to choose q^M or not. If $\hat{v}^M > \tilde{v}^H$, there is a range where the subsidiary bank chooses q^B if the multinational regulator is in charge and \tilde{q}^B if he is not in charge. In the case of $v > v^C$, \tilde{q}^B is more beneficial from a welfare point of view than q^B .¹ In this case, the multinational regulator should not be in charge. Otherwise, the existence of the multinational regulator is welfare-beneficial even if he cannot induce the subsidiary bank to choose q^M . If $v > v_R^M$ and the subsidiary bank still chooses q^M , i.e. $v_R^M < \tilde{v}^M$, the existence of the multinational regulator decreases welfare because v is relatively large and λ relatively low, so that expected bailout costs are relatively high. Then liquidating the subsidiary bank which chose \tilde{q}^B is better from a welfare point of view than rescuing a bank that chose q^M .

The existence of a multinational regulator can also be welfare-efficient in case of intermediate solvency shocks when the host country regulator is not able to bail the subsidiary bank out. In this case, a convex combination of q^M and q^{NH} can replace q^H . Then the home country and the multinational regulator should apply "constructive ambiguity". That is, the multinational regulator should be in charge with probability ω and the home country regulator with probability $1 - \omega$ in such a way that $\omega q^M + [1 - \omega] q^{NH}$ is equal to q^H . By contrast to the previous case, the subsidiary does not know with certainty whether the home country or the multinational regulator is in charge. This policy is equivalent to the optimal bailout probability found by Freixas (1999). Our findings show that "constructive ambiguity" might also be desirable on an institutional level.

5.5 Implementation of the optimal allocation

We switch over from the normative analysis (who should bail out) to the positive analysis (who bails out). Assuming that regulators move successively, each regulator, except the last mover, has three actions available: rescue, liquidate and pass the decision to the successor (henceforth often "pass"). In the previous section, the latter action led to the same payoff for the players as "liquidate". We assume the following sequence:

$$H \rightarrow NH \rightarrow M.$$

With respect to the bailout costs, it might be useful to differentiate between two cases: In the first case, national regulators do not bear the bailout costs if the multinational regulator rescues. Then bailout costs are borne by the regulator who rescues. Assume, for instance, that both the host and the home country are small countries and their contribution to the funding

¹The range $\tilde{v}^H \leq v \leq v^C$ can hold if failure costs C_F are close to zero and the project payoff R is close to 2. See Step 7 of the proof of Proposition 21 in the appendix!

of multinational institutions such as a multinational bailout authority is small. In the second case, national regulators bear the multinational regulator's rescue costs (capital injection v).

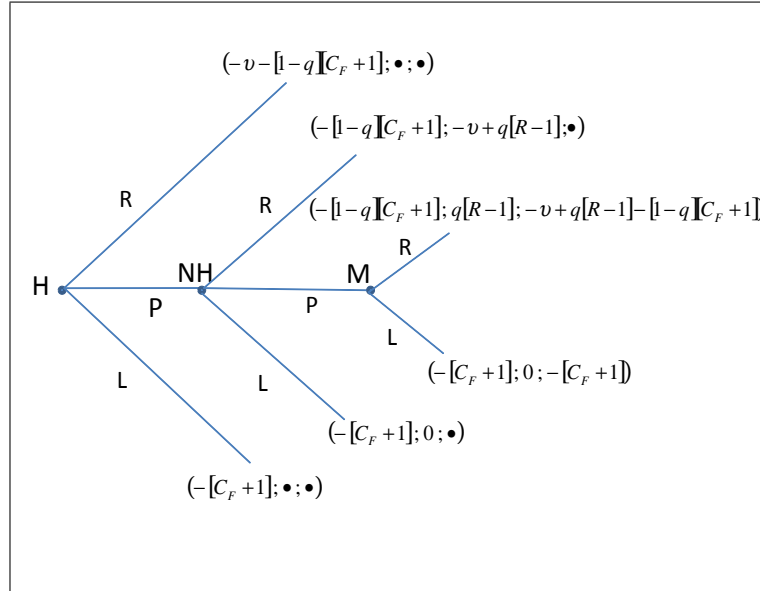
5.5.1 Without sharing of costs for bailout

Figure 5.4 illustrates a subgame, where R stands for the action "rescue", L for the action "liquidate" and P for the action "pass to the successor". If the host country regulator rescues, he receives $-v - [1 - q][C_F + 1]$, the home country regulator generates $q[R - 1]$ and the multinational regulator's payoff amounts to $q[R - 1] - [1 - q][C_F + 1]$. Liquidation by the host country regulator leads to the payoffs $-[C_F + 1]$ for the host and the multinational regulator and zero for the home country regulator. Liquidation payoffs are independent of who liquidates.

If the host country regulator passes the decision to the home country regulator who, in turn, rescues, the host country regulator receives $-[1 - q][C_F + 1]$, the home country regulator generates $-v + q[R - 1]$ and the multinational regulator's payoff amounts to $q[R - 1] - [1 - q][C_F + 1]$.

If the home country regulator passes the decision to the multinational regulator who rescues, the host country regulator receives $-[1 - q][C_F + 1]$, the home country regulator generates $q[R - 1]$ and the multinational regulator's payoff amounts to $-v + q[R - 1] - [1 - q][C_F + 1]$.

Figure 5.4: Game tree of the regulators' game without sharing of bailout costs



Proposition 22 *In a subgame perfect equilibrium*

- the multinational regulator rescues the subsidiary bank if $q \geq q^M$ and liquidates it if $q < q^M$,

- the home country regulator passes the decision to the multinational regulator if $q \geq q^M$ and is indifferent between "liquidating" and "passing" if $q < q^M$,
- the host country regulator passes the decision to the home country regulator if $q \geq q^M$ and is indifferent between "liquidating" and "passing" if $q < q^M$,
- the subsidiary bank chooses

$$q = \begin{cases} q^B; & v < \hat{v}^M \\ q^M; & \hat{v}^M \leq v \leq \tilde{v}^M \\ \tilde{q}^B; & v > \tilde{v}^M \end{cases}.$$

Proof. The rationale is provided below. ■

In Section 5.4.1, we already determined the multinational regulator's decision at the last stage of the game. If $q \geq q^M$, he rescues, whereas in the case of $q < q^M$, he liquidates. Proceeding with the second stage of the subgame, the home country regulator does not have an incentive to intervene if $q \geq q^{NH} > q^M$ because $q[R-1] > -v + q[R-1]$. Similarly, passing the decision to the multinational regulator is more beneficial than liquidating if $q^{NH} > q \geq q^M$ because $q[R-1] > 0$. If $q < q^M$, he is indifferent between liquidating and passing the decision to the multinational regulator since his payoff is always zero.

Similarly, the host country regulator passes the decision to the home country regulator if $q \geq q^M$. Indeed, in the case of $q \geq q^H > q^M$, passing the decision to the home country regulator (who passes the decision to the multinational regulator who, in turn, rescues) is more beneficial than rescuing because $-[1-q][C_F+1] > -v - [1-q][C_F+1]$. This also holds if $q^H > q \geq q^M$ because $-[C_F+1] < -[1-q][C_F+1]$. In the case of $q < q^M$, the host country regulator is indifferent between "liquidate" and "pass" because his payoff is $-[C_F+1]$, independent of whether the home country or the multinational regulator liquidates. Foreseeing the regulators' decisions, the subsidiary bank chooses the same monitoring effort as it would have chosen if only the multinational regulator existed. As a result, the regulators cannot induce the subsidiary bank to choose the higher thresholds q^H and q^{NH} because neither the host nor the home country regulator has an incentive to rescue or to liquidate.

The sequence is not crucial for the result. Independently of who rescues, the subsidiary bank knows ex ante that q^M is sufficient in order to be bailed out in an emergency. Consider, for instance, the sequence, where the multinational regulator moves first. Of course, the multinational regulator does not rescue the subsidiary bank if he expects one of the national regulators to rescue. However, if they have an incentive to liquidate the subsidiary bank, the multinational regulator intervenes and rescues unless $q < q^M$.

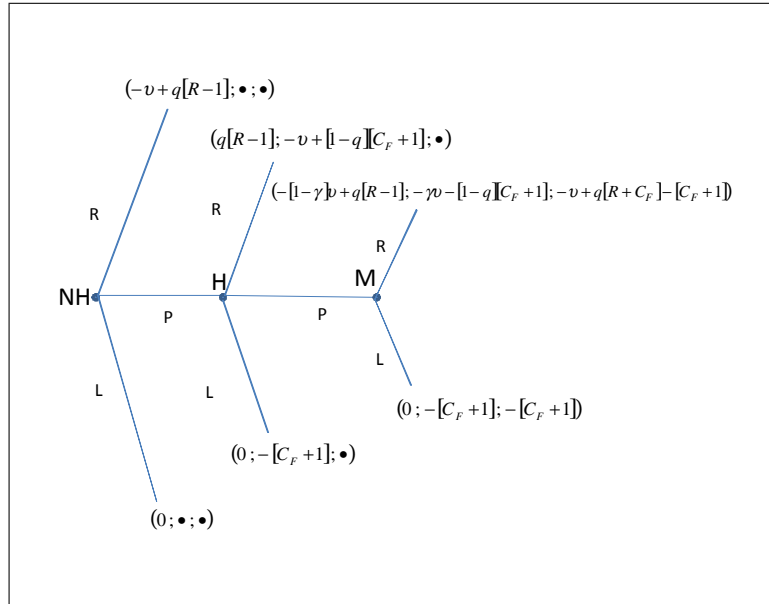
5.5.2 With sharing of costs for bailout

Now we argue that national regulators share the multinational regulator's bailout costs v . The part of the host country regulator's contribution to the funding of these bailouts is denoted

with γ and the home country regulator's part is denoted with $1 - \gamma$. Considering the same sequence as in the previous section, the payoffs are the same until the last stage of the game where the multinational regulator has to decide whether to rescue or to liquidate. If the multinational regulator bails out, the host country regulator's payoff decreases by γv and the home country regulator's payoff by $[1 - \gamma]v$.

To implement the optimal allocation of tasks, we argue that the order has to be changed in such a way that the home country regulator moves first and then the host country regulator decides whether to rescue or to liquidate. If the home country regulator does not intervene, the host country regulator decides whether to pass the decision to the multinational regulator, to rescue or to liquidate the subsidiary bank. Finally, the multinational regulator moves and liquidates or rescues the subsidiary bank. Figure 5.5 illustrates the new subgame of the game.

Figure 5.5: Game tree of the regulators' game with sharing of bailout costs



Beginning with the last stage of the game, we know that the multinational regulator rescues if $q \geq q^M$ and liquidates if $q < q^M$. The host country regulator passes the decision to the multinational regulator if $q \geq q^H$. He is indifferent between "liquidate" and "pass" if $q < q^M$. If the host country regulator has to pay γ of the multinational regulator's bailout costs and $q^H > q \geq q^M$, he prefers to pass the decision to the multinational regulator in the case of $q \geq \frac{\gamma v}{[C_F+1]}$ and to liquidate in the case of $q < \frac{\gamma v}{[C_F+1]}$. This arises from the fact that in the latter case the payoff generated from liquidating the subsidiary bank, i.e. $-[C_F+1]$, is higher than the payoff generated from passing the decision to the multinational regulator, i.e. $-\gamma v - [1-q][C_F+1]$. Setting $\gamma = 1$, the critical threshold $\frac{\gamma v}{[C_F+1]}$ equals q^H and the host country regulator never passes the decision to the multinational regulator, but liquidates in the case of $q < q^H$.

The home country regulator passes the decision to the host country regulator who, in turn, passes the decision to the multinational regulator if $q \geq q^{NH}$. Similar to the host country

regulator, the home country regulator is indifferent between "pass" and "liquidate" if $q < q^M$. The critical values are $q^{NH} > q \geq \frac{\gamma v}{[C_F+1]}$, where the host country regulator passes the burden to the multinational regulator who, in turn, rescues or liquidates the subsidiary bank. In this case, the home country regulator liquidates the subsidiary bank if $[1 - \gamma] \frac{v}{[R-1]} > q$. By setting $\gamma = 0$, the home country regulator does not pass the decision to the host country regulator if $q < q^{NH}$ because the host country regulator would pass the decision to the multinational regulator who, in turn, would bail the subsidiary bank out. However, this is not beneficial for the home country regulator in the case of $[1 - 0] \frac{v}{[R-1]} = q^{NH} > q$.

Proposition 23 *In order to generate the welfare efficient solution*

- *the home country regulator should be forced to pay the multinational regulator's bailout costs if $\hat{v}^{NH} \leq v \leq \tilde{v}^{NH}$,*
- *the host country regulator should be forced to pay the multinational regulator's bailout costs if $\hat{v}^H \leq v \leq \tilde{v}^H$,*
- *"third parties" should bear the costs if $v > \tilde{v}^H$.*

Proof. The rationale is provided below. ■

Foreseeing the outcome of the regulators' game, the subsidiary bank chooses q^{NH} if $\hat{v}^{NH} \leq v \leq \tilde{v}^{NH}$ and q^H if $\hat{v}^H \leq v \leq \tilde{v}^H$. This optimal burden sharing can only be implemented if the home country regulator moves first. Assume, by contrast, that the host country regulator moves first and knows that the home country regulator has to pay the whole bailout costs of the multinational regulator. Then the host country regulator does not pass the decision to the home country regulator unless $q < q^H$. Indeed, in the case of $q^{NH} > q \geq q^H$, the host country regulator rescues because his payoff is higher than if the home country regulator liquidates. Foreseeing the host country regulator's decision, the subsidiary bank does not choose $q > q^H$ in order to guarantee a bailout if necessary. Hence, q^{NH} is not feasible.

If the multinational regulator moves first, or at least not at the end, he always rescues the subsidiary bank if he expects the national regulators to liquidate and $q \geq q^M$. This is, for instance, the case when $q^M < q < q^H$. Then the national regulators do not have an incentive to rescue the subsidiary bank which induces the multinational regulator, in turn, to bail out the bank. Foreseeing the regulators' incentives, the subsidiary bank never chooses a monitoring effort $q > q^M$ in order to be rescued. Therefore, we obtain the same result as in the previous section where national regulators do not finance the multinational regulator's capital injection.

5.6 Allocation of bailout responsibility between a parent bank and a regulator

5.6.1 Bailout incentives of the parent bank

We start with the simple case where the subsidiary bank can only ask its parent bank to bail it out.

Lemma 24 *The subsidiary bank chooses*

- q^B and is rescued by its parent bank if

$$v \leq \frac{1}{2\phi} [R - 1]^2 =: v^{BB},$$

- \tilde{q}^B and is liquidated by its parent bank if

$$v > v^{BB}.$$

Proof. The proof can be found in the appendix. ■

If the solvency shock is relatively low, $v \leq v^{BB}$, the parent bank rescues its subsidiary because bailout costs are sufficiently low. From Section 5.4.3, we already know that the subsidiary bank's optimal effort level is then q^B . By contrast, if the solvency shock is sufficiently high, bailout costs are relatively high and the subsidiary bank gambles, i.e. chooses \tilde{q}^B .

Now we allow for a bailout by the parent bank and a bailout by either the national (host or home) or the multinational regulator. The game structure is the same as in Section 5.4, except for the fact that the parent bank decides whether to rescue its subsidiary bank before the regulator in charge moves.

Proposition 25 *The parent bank never rescues if any of the regulators is in charge.*

Proof. The proof can be found in the appendix! ■

Comparing rescuing the subsidiary bank and relying on the safety net, the parent bank chooses the first one if the solvency shock is sufficiently large. This results from the fact that an increasing solvency shock raises the required threshold level q^{RE} . However, an increasing solvency shock raises bailout costs, too. If the solvency shock is too high for accepting the safety net, a bailout is also too expensive for the parent bank. Consequently, the parent bank never rescues if any of the regulators is in charge.

By ensuring that the parent bank publicly commits itself to recapitalize, thus to rescue its subsidiary, the regulators cannot prevent the parent bank from relying on the safety net.²

²In this paper we do not address the question of how the regulator can induce the parent bank to restore its subsidiary.

However, the safety net also has a positive effect, since the subsidiary bank chooses a higher monitoring effort which increases the probability of project success. From an aggregate welfare point of view, it does not matter who pays the bill of a bailout. Therefore, the existence of a safety net is welfare-increasing, since it induces the subsidiary bank to increase its monitoring effort, at least for intermediate solvency shocks.

5.6.2 Cooperation between regulator and parent bank

Now we assume that the parent bank does not rescue its subsidiary voluntarily because the solvency shock is too large, $v > v^{BB}$. Then the regulators have three options:

- Firstly, they can force the parent bank to rescue its subsidiary. Then the subsidiary bank chooses q^B .
- Secondly, the regulators can offer a safety net without requiring any repayments. Then we are in the same case as in Section 5.4.1.
- Thirdly, the regulators can offer a safety net and force the parent bank to pay a part of the bailout bill.

We follow the third option and assume that the parent bank has to inject θ . On the one hand, θ reduces the capital injection which the host country regulator needs to ensure the continuation of the subsidiary bank. This decreases threshold level q^H . On the other hand, the parent bank has to pay θ if the subsidiary bank demands a bailout. We consider θ as a lump-sum charge and ask whether a contribution by the parent bank to the bailout of its subsidiary can increase the range where the subsidiary bank chooses the required monitoring effort q^H .³ If the home regulator or the multinational regulator is in charge, an increase of θ does not decrease the thresholds q^M and q^{NH} .

Proposition 26 *We have to differentiate between the regulators.*

- Assume that the host country regulator is in charge. Then an increase of θ (at $\theta = 0$) can increase \tilde{v}^H if

$$\lambda > 1 - 2 \frac{[R - 1]^2}{[C_F + 1]^2 + [R - 1]^2} =: \lambda^H.$$

- An increase of θ always decreases \tilde{v}^M and \tilde{v}^{NH} .

Proof. The proof can be found in the appendix! ■

Cooperation between a regulator and the parent bank can increase the range where the subsidiary bank chooses its required monitoring effort level q^H if λ is sufficiently large. The reason is that, on the one hand, a small contribution to the restoration decreases the parent

³As we restrict our attention on a marginal effect of θ at point $\theta = 0$, it does not matter whether we consider θ as a lump-sum "tax" or as a levy depending on v .

bank's payoff, but, on the other hand, it decreases the required monitoring effort. If the solvency shock only occurs with a sufficiently small probability, i.e. λ is sufficiently high, the expected loss due to its own contribution to the recovery is relatively small and therefore it is beneficial for the parent bank to partly contribute to the rescue of the subsidiary bank.

A contribution of the parent bank does not change the thresholds q^M and q^{NH} because it does not change welfare in the home country. Therefore, a bailout by either the multinational or the home country regulator increases "costs" for the parent bank without decreasing the required thresholds. Obviously, this leads to a decrease of the range (of v), where the subsidiary bank accepts q^M and q^{NH} , respectively, in order to be rescued.

5.7 Conclusion

We asked whether the implementation of a multinational regulator, dealing with bailouts and resolutions of a subsidiary bank, is desirable and how these bailout costs should be financed. Moreover, we analysed the benefit of burden sharing among regulators and between regulators and parent banks.

To address these issues, we developed an incomplete-contract model, where a subsidiary bank first decides about its monitoring effort. Thereafter, the subsidiary bank is hit by a solvency shock with an exogenously determined probability. Then it cannot continue to operate unless it is bailed out. We differentiate between host, home and multinational regulators. We assumed that the regulators bail out the subsidiary bank if the rescue costs are lower than the liquidation costs. This holds if the bank's monitoring effort exceeds a certain monitoring threshold which is different among host, home and multinational regulators, since the national regulators maximize domestic welfare, whereas the multinational regulator maximizes aggregate welfare.

Our results suggest that in the case of sufficiently low solvency shocks it does not matter who bails out, since the required monitoring effort levels are not binding. In the case of very low shocks, the home country regulator should rescue the subsidiary, whereas in the case of low shocks, the host country regulator should be in charge. The multinational regulator should rescue or liquidate subsidiary banks that are hit by intermediate shocks. The allocation of resolution power does not matter if solvency shocks are sufficiently high, as neither the national nor the multinational regulator can induce the subsidiary bank to choose a monitoring effort above the gambling effort level.

The implementation of such an allocation of tasks requires burden sharing of bank bailouts in such a way that the home country regulator should be forced to bear the multinational regulator's bailout costs if the solvency shock is very low. In the case of low shocks, the host country regulator should bear the multinational regulator's bailout costs. In the case of intermediate shocks, the national regulators' contribution should be as small as possible.

Finally, we argue that a regulator might decrease welfare if he forces the parent bank to bail out its subsidiary. We rather suggest that the host country regulator and the parent

bank should cooperate in rescuing the subsidiary bank, which can increase the range where the subsidiary bank chooses a higher monitoring effort if the probability of a solvency shock is sufficiently low. This effect does not exist if the home or the multinational regulator is in charge.

Our results are based upon a number of assumptions, and it may be worthwhile to check how critical they are. Firstly, we assumed that costs of failure do not differ between the host and the multinational regulator. This assumption is not critical to our main finding that burden sharing is necessary to implement the optimal allocation of resolution power, but solely changes the relative size of regulators' thresholds. Secondly, we analysed the incentives using a specific cost function. However, we allow for the variation of monitoring efficiency. Thirdly, we assumed that the subsidiary bank does not have to repay capital that was injected. If the subsidiary bank has to repay the capital injection, regulator's thresholds decrease.

The model can be expanded in several ways. Firstly, we do not internalize the subsidiary bank's decision to invest abroad. Secondly, we only account for a single subsidiary bank. Mikkonen (2006) shows that the relative threshold level of the multinational regulator can change and be lower than the national regulator's threshold level when taking more than one subsidiary of a multinational regulator into account. Then the optimal allocation of resolution power depends on the number of banks. Thirdly, the subsidiary bank is only financed by secured deposits. Beck et al. (2011), for example, analyse the distortions assets, deposits and equity introduce in the regulatory process of cross-border banking. Finally, the set-up can be used to model bargaining solutions between the regulators and/or between the regulators and the bank.

Nevertheless, our paper provides some insights into the risk incentives of multinational banks and shows why the implementation of a multinational regulator and burden sharing among national regulators might be welfare-improving. This chapters illustrates that cooperation and financing agreements should not necessarily lead to a joint resolution or bailout of insolvent multinational banks, but may imply an allocation of responsibilities depending on the type of the crisis. The same holds true for the financing arrangements.

Appendix

Proof of Proposition 17

In order to determine the optimal monitoring effort for a welfare-maximizing bank, we proceed in three major steps and, in each major step we proceed in three minor steps. First, we differentiate between three different values of monitoring efficiency:

1. $\phi \geq R + C_F$
2. $\lambda [R + C_F] \leq \phi < R + C_F$

$$3. \phi < \lambda [R + C_F],$$

which we define as the three major steps. Then in each major step we differentiate between three minor steps:

- $q^M < \tilde{q}^* < q^*$
- $\tilde{q}^* < q^M < q^*$
- $\tilde{q}^* < q^* < q^M$.

Step 1

In this case, efficiency costs lead to the fact that $q^* \leq 1$.

- First, assume that $q^M < \tilde{q}^* < q^*$. As $W = W^R$ for $q \geq q^M$, \tilde{q}^* cannot be optimal because $W^R(q^*) > W^R(\tilde{q}^*)$. It can be shown that $W^R(q^*) > W^L(q^M)$ holds for all $v \in [0, 1]$. Hence, there cannot be a monitoring effort which leads to a higher effort level under liquidation than under bailout. Notice that we are in the range where $\tilde{q}^* > q^M$ or, equivalently:

$$v < \frac{\lambda}{\phi} [R + C_F]^2.$$

- Second, assume $\tilde{q}^* < q^M < q^*$. In this case, the welfare-maximizing subsidiary bank either chooses \tilde{q}^* or q^* . We have $W^R(q^*) > W^L(\tilde{q}^*)$ if

$$v < \frac{1}{2} \frac{1}{\phi} [R + C_F]^2 [1 + \lambda].$$

However, we are in the range where $q^* > q^M > \tilde{q}^*$ or, equivalently:

$$\frac{\lambda}{\phi} [R + C_F]^2 < v < \frac{1}{\phi} [R + C_F]^2.$$

Therefore, we have $W^R(q^*) > W^L(\tilde{q}^*)$ if $\frac{\lambda}{\phi} [R + C_F]^2 < v < \frac{1}{2} \frac{1}{\phi} [R + C_F]^2 [1 + \lambda]$, which always holds since $\lambda < 1$.

- Third, assume that $\tilde{q}^* < q^* < q^M$. We have to check whether $W^R(q^M) > W^L(\tilde{q}^*)$. It is easy to check that this inequation can never be fulfilled and we always have $W^L(\tilde{q}^*) > W^R(q^M)$. To conclude, in the case of $\phi \geq C_F + R$ we have to differentiate between two cases:

$$q^W = \begin{cases} q^*; & v \leq \frac{1}{2} \frac{1}{\phi} [R + C_F]^2 [1 + \lambda] \\ \tilde{q}^*; & v > \frac{1}{2} \frac{1}{\phi} [R + C_F]^2 [1 + \lambda] \end{cases}.$$

Step 2

In this case, we have $\tilde{q}^* < 1 < q^*$. Now the subsidiary bank cannot choose q^* .

- First, assume that $q^M < \tilde{q}^* < 1$. As the profit is increasing in q for $q < q^*$, we have $W^R(1) > W^R(\tilde{q}^*)$. However, we have to check whether $W^R(1) < W^L(q^M)$ holds. It is easy to check that $W^R(1) > W^L(q^M)$ always holds.
- Second, assume that $\tilde{q}^* < q^M < 1$. Then we have to check whether $W^R(1) > W^L(\tilde{q}^*)$, which holds if

$$v < \frac{[R + C_F] - \frac{1}{2} \frac{\lambda^2}{\phi} [R + C_F]^2 - \frac{1}{2} \phi}{[1 - \lambda]}.$$

- The third case $\tilde{q}^* < 1 < q^M$ is impossible, since $q \in [0, 1]$. To conclude, the welfare-optimizing subsidiary bank chooses:

$$q^W = \begin{cases} 1; & v \leq \frac{[R + C_F] - \frac{1}{2} \frac{\lambda^2}{\phi} [R + C_F]^2 - \frac{1}{2} \phi}{[1 - \lambda]} \\ \tilde{q}^*; & v > \frac{[R + C_F] - \frac{1}{2} \frac{\lambda^2}{\phi} [R + C_F]^2 - \frac{1}{2} \phi}{[1 - \lambda]} \end{cases}.$$

Step 3

In this case, we have $1 < \tilde{q}^* < q^*$. Therefore, we only have to consider the case where $q^M < \tilde{q}^* = 1$. The subsidiary bank either chooses q^M , which leads to the liquidation, or $q = 1$. From Case 2 we already know that $W^R(1) > W^L(q^M)$ always holds and therefore the welfare-optimizing subsidiary bank chooses always $q = 1$, i.e.

$$q^W = 1.$$

Proof of Proposition 18

Assume that the host country regulator is in charge. In the binding case, the bank chooses its first-best monitoring effort \tilde{q}^B if

$$\pi(\tilde{q}^B) > \pi(q^H)$$

or equivalently if

$$\frac{1}{2} \frac{\lambda^2}{\phi} [R - 1]^2 > q^H [R - 1] - \frac{1}{2} \phi [q^H]^2.$$

Solving the inequation, we obtain:

$$q^H < \frac{1}{\phi} [R - 1] \left[1 - \sqrt{[1 - \lambda^2]} \right] =: q_-^H \text{ or } \frac{1}{\phi} [R - 1] \left[1 + \sqrt{[1 - \lambda^2]} \right] =: q_+^H < q^H.$$

In the case of $q^H < \frac{1}{\phi} [R - 1] \left[1 - \sqrt{[1 - \lambda^2]} \right]$, the threshold level is not binding. To see this, remember that q^H is binding only if $\tilde{q}^B < q^H$. This is equivalent to $\frac{\lambda}{\phi} [R - 1] < q^H$.

We have $\frac{\lambda}{\phi} [R - 1] \geq \frac{1}{\phi} [R - 1] \left[1 - \sqrt{[1 - \lambda^2]} \right]$ because $0 \leq \lambda \leq 1$. Therefore only one solution to the inequation remains and the subsidiary bank chooses \tilde{q}^B if

$$q^H > q_+^H,$$

which is equivalent to

$$v > \frac{1}{\phi} [R - 1] \left[1 + \sqrt{[1 - \lambda^2]} \right] [C_F + 1] =: \tilde{v}^H.$$

Notice that the threshold for $\pi(q^B) > \pi(q^H)$ can be achieved in the same way or by setting $\lambda = 1$.

Assume that the multinational regulator has the resolution power. Then the subsidiary bank chooses \tilde{q}^B if

$$\pi(\tilde{q}^B) > \pi(q^M)$$

or, equivalently, if $(\tilde{v}_-^M = \frac{1}{\phi} [R - 1] \left[1 - \sqrt{[1 - \lambda^2]} \right] [C_F + R])$ can be neglected, since $v > \tilde{v}_-^M$)

$$v > \frac{1}{\phi} [R - 1] \left[1 + \sqrt{[1 - \lambda^2]} \right] [C_F + R] =: \tilde{v}^M.$$

Notice that the threshold for $\pi(q^B) > \pi(q^M)$ can be achieved in the same way.

Assume that the national regulator of the home country controls and the parent bank cannot rescue its subsidiary. Then the subsidiary bank gambles if

$$\pi(\tilde{q}^B) > \pi(q^{NH})$$

or equivalently if

$$\frac{1}{2} \frac{\lambda^2}{\phi} [R - 1]^2 > q^{NH} [R - 1] - \frac{1}{2} \phi [q^{NH}]^2.$$

Solving the inequation we have:

$$v < \frac{1}{\phi} [R - 1]^2 \left[1 - \sqrt{[1 - \lambda^2]} \right] := \tilde{v}_-^{NH} \text{ or } \frac{1}{\phi} [R - 1]^2 \left[1 + \sqrt{[1 - \lambda^2]} \right] =: \tilde{v}^{NH} < v.$$

However, we can neglect the second condition $v < \tilde{v}_-^{NH}$ as the required monitoring level is not binding. Therefore, the subsidiary bank chooses q^{NH} if the home country regulator controls and $\tilde{v}^{NH} < v$. Notice that $\pi(q^B) > \pi(q^{NH})$ can be obtained in the same way.

Proof of Lemma 19

- We have $W^R(q^M) > W^L(\tilde{q}^B)$ if

$$\frac{\lambda}{\phi} [R + C_F] [R - 1] < v < \frac{\lambda}{\phi} [R + C_F] [2[R + C_F] - [R - 1]].$$

Notice that $\frac{\lambda}{\phi} [R + C_F] [R - 1] < \hat{v}^M$ (remember that \hat{v}^M is defined in Proposition 18) and, therefore, it remains:

$$v < \frac{\lambda}{\phi} [R + C_F] [2 [R + C_F] - [R - 1]] =: v_R^M,$$

which can either be higher or lower than \tilde{v}^M .

- We have $W^R(q^H) > W^L(\tilde{q}^B)$ if

$$v > \frac{1}{\phi} [C_F + 1] \left[[R - 1 + \lambda [C_F + 1]] - \sqrt{[R - 1 + \lambda [C_F + 1]]^2 - \lambda^2 [R - 1] [2 [R + C_F] - [R - 1]]} \right]$$

and

$$v < \frac{1}{\phi} [C_F + 1] \left[[R - 1 + \lambda [C_F + 1]] + \sqrt{[R - 1 + \lambda [C_F + 1]]^2 - \lambda^2 [R - 1] [2 [R + C_F] - [R - 1]]} \right].$$

However, it can be shown that:

$$\begin{aligned} & \frac{1}{\phi} [C_F + 1] \left[[R - 1 + \lambda [C_F + 1]] - \sqrt{[R - 1 + \lambda [C_F + 1]]^2 - \lambda^2 [R - 1] [2 [R + C_F] - [R - 1]]} \right] \\ & < \frac{1}{\phi} [R - 1] [C_F + 1] = \hat{v}^H, \end{aligned}$$

and, therefore, it remains

$$v < \frac{1}{\phi} [C_F + 1] \left[[R - 1 + \lambda [C_F + 1]] + \sqrt{[R - 1 + \lambda [C_F + 1]]^2 - \lambda^2 [R - 1] [2 [R + C_F] - [R - 1]]} \right].$$

Consider

$$\begin{aligned} & \frac{1}{\phi} [R - 1] [1 + C_F] \left[1 + \sqrt{1 - \lambda^2} \right] = \tilde{v}^H \\ & < \frac{1}{\phi} [C_F + 1] \left[[R - 1 + \lambda [C_F + 1]] + \sqrt{[R - 1 + \lambda [C_F + 1]]^2 - \lambda^2 [R - 1] [2 [R + C_F] - [R - 1]]} \right]. \end{aligned}$$

If $[R - 1] \sqrt{1 - \lambda^2} < \lambda [C_F + 1]$, this inequation is always true. If $[R - 1] \sqrt{1 - \lambda^2} >$

$\lambda [C_F + 1]$, this holds if

$$\begin{aligned} & [R - 1]^2 [1 - \lambda^2] - 2\lambda [C_F + 1] [R - 1] \sqrt{1 - \lambda^2} + \lambda^2 [C_F + 1]^2 \\ & < [R - 1 + \lambda [C_F + 1]]^2 - \lambda^2 [R - 1] [2 [R + C_F] - [R - 1]], \end{aligned}$$

which is always true. Hence, we have the result that $W^R(q^H) > W^L(\tilde{q}^B)$ as long as $\hat{v}^H \leq v \leq \tilde{v}^H$.

- We have $W^R(q^{NH}) > W^L(\tilde{q}^B)$ if

$$\begin{aligned} v & > \frac{1}{\phi} [R - 1] \\ & \left[C_F + 1 + \lambda [R - 1] - \sqrt{[R + C_F] - [1 - \lambda] [R - 1]]^2 - \lambda^2 [R - 1] [R + 2C_F + 1]} \right] \end{aligned}$$

and

$$\begin{aligned} v & < \frac{1}{\phi} [R - 1] \\ & \left[C_F + 1 + \lambda [R - 1] + \sqrt{[R + C_F] - [1 - \lambda] [R - 1]]^2 - \lambda^2 [R - 1] [R + 2C_F + 1]} \right]. \end{aligned}$$

We have $v_1 < \hat{v}^{NH}$ if

$$\begin{aligned} & [C_F + 1]^2 - 2 [R - 1] [C_F + 1] + 2 [R - 1] [R + C_F] \\ & < [R + C_F]^2 + \lambda^2 [R - 1]^2 - 2\lambda^2 [R - 1] [R + C_F] + 2\lambda [R - 1]^2. \end{aligned}$$

Let us consider the following function f :

$$f(\lambda) = \lambda^2 [R - 1]^2 - 2\lambda^2 [R - 1] [R + C_F] + 2\lambda [R - 1]^2.$$

The first-order derivative with respect to λ is given by:

$$\frac{\partial f}{\partial \lambda} = 2\lambda [R - 1]^2 - 4\lambda [R - 1] [R + C_F] + 2 [R - 1]^2.$$

The second-order derivative is given by:

$$\frac{\partial^2 f}{\partial \lambda^2} = 2 [R - 1]^2 - 4 [R - 1] [R + C_F] < 0.$$

We have a maximum at point

$$\lambda = \frac{R - 1}{2 [R + C_F] - [R - 1]}.$$

Therefore, if the inequation holds for $\lambda = 0$ and $\lambda = 1$, it holds for all $\lambda \in [0, 1]$. For

$\lambda = 0$ we have:

$$[C_F + 1]^2 - 2[R - 1][C_F + 1] + 2[R - 1][R + C_F] < [R + C_F]^2$$

and rearranging the inequation leads to:

$$C_F + 1 < R + C_F.$$

For $\lambda = 1$ we have:

$$\begin{aligned} & [C_F + 1]^2 - 2[R - 1][C_F + 1] + 2[R - 1][R + C_F] \\ & \leq [R + C_F]^2 + [R - 1]^2 - 2[R - 1][C_F + 1], \end{aligned}$$

which is equivalent to:

$$[C_F + 1]^2 \leq [C_F + 1]^2.$$

Hence, the inequation is fulfilled if it is not strict. As a result, for the solution of the inequation, it remains:

$$\begin{aligned} v & < \frac{1}{\phi} [R - 1] \\ & \quad \left[C_F + 1 + \lambda [R - 1] + \sqrt{[[R + C_F] - [1 - \lambda][R - 1]]^2 - \lambda^2 [R - 1][R + 2C_F + 1]} \right]. \end{aligned}$$

It remains to check whether $\tilde{v}^{NH} < v_2$ which holds if

$$\begin{aligned} & [R - 1] \left[1 - \lambda + \sqrt{1 - \lambda^2} \right] - [C_F + 1] \\ & < \sqrt{[[R + C_F] - [1 - \lambda][R - 1]]^2 - \lambda^2 [R - 1][2[R + C_F] - [R - 1]]}. \end{aligned}$$

If the left side is less than zero, we do not have any problem and the inequation is fulfilled. By contrast, if the left side is greater than zero, we obtain:

$$[R - 1] \left[1 - \lambda + \sqrt{1 - \lambda^2} \right]^2 < 2[C_F + 1] \left[1 - \lambda^2 + \sqrt{1 - \lambda^2} \right].$$

We know that

$$\left[1 - \lambda + \sqrt{1 - \lambda^2} \right]^2 < 2 \left[1 - \lambda^2 + \sqrt{1 - \lambda^2} \right],$$

and since $[C_F + 1] > [R - 1]$, the inequation is fulfilled. Hence, we have always $W^R(q^{NH}) > W^L(\tilde{q}^B)$ if $\hat{v}^{NH} < \tilde{v}^{NH}$.

Proof of Lemma 20

- We have $W^R(q^M) > W^R(q^H)$ if

$$q^M [R + C_F] - c(q^M) > q^H [R + C_F] - c(q^H)$$

or, equivalently, if

$$\frac{1}{2}\phi v^2 [[R + C_F]^2 - [C_F + 1]^2] + v [R + C_F]^2 [C_F + 1] [[C_F + 1] - [R + C_F]] > 0.$$

The inequation is fulfilled if

$$v < 0$$

or

$$v > 2 \frac{[R + C_F]^2 [C_F + 1] [R - 1]}{\phi [[R + C_F]^2 - [C_F + 1]^2]} =: v^{MH},$$

where v^{MH} is equal to:

$$\frac{2 [R + C_F]^2 [C_F + 1]}{\phi [R + C_F] + [C_F + 1]}.$$

As a result, the multinational regulator leads to a higher welfare if

$$v > v^{MH}.$$

- We have $W^R(q^M) > W^R(q^{NH})$ if

$$q^M [R + C_F] - c(q^M) > q^{NH} [R + C_F] - c(q^{NH})$$

or, equivalently, if

$$-v [R - 1] [R + C_F]^2 [C_F + 1] + \frac{1}{2}\phi v^2 [[R + C_F]^2 - [R - 1]^2] > 0.$$

The inequation is fulfilled if

$$v < 0$$

or

$$v > \frac{2 [R - 1] [C_F + 1] [R + C_F]^2}{\phi [[R + C_F]^2 - [R - 1]^2]} =: v^{MNH}.$$

As a result, the multinational regulator leads to a higher welfare if

$$v > v^{MNH}.$$

- We have $W^R(q^H) > W^R(q^{NH})$ if

$$q^H [R + C_F] - c(q^H) > q^{NH} [R + C_F] - c(q^{NH})$$

or, equivalently, if

$$\frac{1}{2}\phi v^2 [[C_F + 1]^2 - [R - 1]^2] + v [R + C_F] [R - 1] [C_F + 1] [[R - 1] - [C_F + 1]] > 0.$$

The inequation is fulfilled if

$$v < 0$$

or

$$v > \frac{2 [R + C_F] [R - 1] [C_F + 1] [[C_F + 1] - [R - 1]]}{\phi [[C_F + 1]^2 - [R - 1]^2]} =: v^{HNNH},$$

where v^{HNNH} is equal to:

$$\frac{2 [R - 1] [C_F + 1]}{\phi}.$$

As a result, the host country regulator leads to a higher welfare if $v > v^{HNNH}$.

- Comparing these thresholds, we have $v^{MH} > v^{MNNH} > v^{HNNH}$.

Proof of Proposition 21

We proceed in seven steps:

Step 1

It can be shown that $v^{HNNH} > \tilde{v}^{NH}$. Consequently, the home country regulator should rescue in the case of $\hat{v}^{NH} \leq v \leq \tilde{v}^{NH}$.

Step 2

We know that $v^{MH} > \tilde{v}^H$ and, therefore, the host country regulator should rescue in the case of $\tilde{v}^{NH} \leq v \leq \tilde{v}^H$ as long as $\tilde{v}^{NH} > \hat{v}^H$.

Step 3

The subsidiary bank chooses the multinational regulator's threshold q^M in the case of $\hat{v}^M \leq v \leq \tilde{v}^M$. However, he should only rescue in the case of $\tilde{v}^H \leq v \leq \min(v_R^M; \tilde{v}^M)$ as long as $\tilde{v}^H > \hat{v}^M$.

Step 4

It remains to be examined whether "as long as" is necessary in Steps 2 and 3. Therefore we check whether $W^R(q^B) > W^L(\tilde{q}^B)$. This holds if

$$\frac{1}{\phi} [R - 1] [1 + \lambda] \left[[R + C_F] - \frac{1}{2} [R - 1] \right] > v =: v^C.$$

We know that $v^C > \hat{v}^H$ and therefore, the "as long as" in step two can be deleted. However, we know that $v^C > \hat{v}^M$ if

$$\lambda > \frac{\frac{1}{2} [R - 1]}{[R + C_F] - \frac{1}{2} [R - 1]}.$$

Therefore, we cannot exclude $v^C < \hat{v}^M$. Moreover, we cannot exclude $v^C < \tilde{v}^H$. We have to prove whether \tilde{q}^B leads to a bailout, too, i.e. $\tilde{q}^B > q^M$,

$$\frac{\lambda}{\phi} [R - 1] [R + C_F] > v =: v^L.$$

Notice that if $v^C < \hat{v}^M$, we definitely have $v^L < \tilde{v}^H$, which is easy to show. Consequently, if there is a range where $\tilde{v}^H < v^C < v < \hat{v}^M$, we can argue that $W^L(\tilde{q}^B) > W^R(q^B)$ because $v^L < \tilde{v}^H$ and the subsidiary bank is indeed liquidated in the case of choosing \tilde{q}^B .

Step 5

We know that $W^R(q^{NH}) > W^R(q^B)$ as long as

$$q^{NH} [R + C_F] - c(q^{NH}) > q^B [R + C_F] - c(q^B)$$

or, equivalently,

$$\phi^2 v^2 - 2\phi v [R + C_F] [R - 1] + 2 [R - 1]^3 [R + C_F] - [R - 1]^4 < 0.$$

The solution of the inequation is given by:

$$\frac{1}{\phi} [R - 1]^2 \leq v \leq \frac{1}{\phi} [R - 1] [[R + C_F] + [C_F + 1]].$$

We have $v_2 > \tilde{v}^{NH}$ if

$$\frac{1}{\phi} [R - 1] [[R + C_F] + [C_F + 1]] > \frac{1}{\phi} [R - 1]^2 [1 + \sqrt{1 - \lambda^2}]$$

or, equivalently,

$$[R + C_F] + [C_F + 1] > [R - 1] [1 + \sqrt{1 - \lambda^2}].$$

We see that the right side decreases in λ . Assuming $\lambda = 0$, we have:

$$[R + C_F] + [C_F + 1] > 2[R - 1]$$

or, equivalently,

$$2C_F + 1 > R - 2,$$

which is always fulfilled, as the right side is negative.

Step 6

We know that $W^R(q^H) > W^R(q^B)$ as long as

$$q^H [R + C_F] - c(q^H) > q^B [R + C_F] - c(q^B)$$

or, equivalently,

$$\phi^2 v^2 - 2\phi v [R + C_F] [C_F + 1] + 2[R - 1] [R + C_F] [C_F + 1]^2 - [R - 1]^2 [C_F + 1]^2 < 0.$$

The solution of the inequation is given by:

$$\frac{[C_F + 1] [R - 1]}{\phi} \leq v \leq \frac{[C_F + 1] [[R + C_F] + [C_F + 1]]}{\phi},$$

where $v_2 \geq \tilde{v}^H$ (same proof as in Step 5).

Step 7

We cannot show that the differentiation between $v^C < \hat{v}^M$ and $v^C \geq \hat{v}^M$ is not necessary. If $\tilde{v}^H < \hat{v}^M$, we have $v^C > \hat{v}^M$. The first inequation holds if

$$\frac{1}{\phi} [R - 1] [1 + C_F] \left[1 + \sqrt{1 - \lambda^2} \right] < \frac{1}{\phi} [R - 1] [C_F + R]$$

or, equivalently, if

$$\lambda > \sqrt{1 - \frac{[R - 1]^2}{[1 + C_F]^2}}.$$

The second inequation holds if

$$\frac{1}{\phi} [R - 1] [C_F + R] < \frac{1}{\phi} [R - 1] [1 + \lambda] \left[[R + C_F] - \frac{1}{2} [R - 1] \right]$$

or, equivalently, if

$$\lambda > \frac{\frac{1}{2} [R - 1]}{[R + C_F] - \frac{1}{2} [R - 1]}.$$

We show that the following inequation can hold:

$$\sqrt{1 - \frac{[R-1]^2}{[1+C_F]^2}} < \frac{\frac{1}{2}[R-1]}{[R+C_F] - \frac{1}{2}[R-1]}.$$

Set $C_F = 0$ which leads to:

$$1 - [R-1]^2 < \frac{[R-1]^2}{[R+1]^2}.$$

Rearranging the inequation, we obtain:

$$4R < [R+1]^2 [R-1]^2,$$

which is true for $R = 2$. Consequently, there is a possible range if failure costs C_F are very low and return R is very high.

Proof of Lemma 24

Assume that the parent bank rescues. Then the subsidiary bank chooses q^B and the parent bank's net profit amounts to $-v[1-\lambda] + \frac{1}{2\phi}[R-1]^2$. In the case of a liquidation, the parent bank only receives the net payoff of its subsidiary if the shock does not appear. Hence, the expected net profit amounts to $\frac{\lambda}{2\phi}[R-1]^2$. Obviously, rescuing its subsidiary is more beneficial than liquidating if

$$-v[1-\lambda] + \frac{1}{2\phi}[R-1]^2 \geq \frac{\lambda}{2\phi}[R-1]^2$$

or, equivalently, if

$$v \leq \frac{1}{2\phi}[R-1]^2 =: v^{BB}.$$

Proof of Proposition 25

Assume that the host country regulator has power of resolution. Notice that the parent bank is the unique owner of the subsidiary bank, which means that it can force its subsidiary to choose a certain threshold level. Accordingly, restoring the subsidiary bank is only beneficial if $v \leq v^{BB}$ and the net expected profit from rescuing is higher than the net expected profit of forcing the subsidiary bank to follow the regulator's required threshold level q^H . This holds if

$$-v[1-\lambda] + \pi(q^B) \geq \pi(q^H)$$

or, equivalently, if

$$-v[1-\lambda] + \frac{1}{2\phi}[R-1]^2 \geq \frac{v}{C_F+1}[R-1] - \frac{1}{2}\phi \left[\frac{v}{C_F+1} \right]^2.$$

Solving the inequation, we obtain:

$$v \leq \bar{v}_-^H \vee \bar{v}_+^H \leq v,$$

with

$$\bar{v}_-^H = \frac{1}{\phi} [C_F + 1] \left[[1 - \lambda] [C_F + 1] + [R - 1] - \sqrt{[1 - \lambda] \left[[1 - \lambda] [C_F + 1]^2 + 2 [C_F + 1] [R - 1] \right]} \right],$$

which is irrelevant because $\bar{v}_-^H < \hat{v}^H$ and

$$\bar{v}_+^H = \frac{1}{\phi} [C_F + 1] \left[[1 - \lambda] [C_F + 1] + [R - 1] + \sqrt{[1 - \lambda] \left[[1 - \lambda] [C_F + 1]^2 + 2 [C_F + 1] [R - 1] \right]} \right].$$

Now it remains to check whether the parent bank ever rescues if the host country regulator is in charge. It is easy to show that:

$$v^{BB} < \frac{1}{\phi} [C_F + R] \left[[1 - \lambda] [C_F + R] + [R - 1] \right]$$

for all $\lambda < 1$ and therefore $v^{BB} < \bar{v}_+^H$. Hence, the parent bank never rescues if the host country regulator is in charge.

Assume that the multinational regulator has the power of resolution. Then the parent bank rescues its subsidiary bank if $v \leq v^{BB}$ and

$$-v [1 - \lambda] + \pi (q^B) \geq \pi (q^M)$$

or equivalently

$$-v [1 - \lambda] + \frac{1}{2\phi} [R - 1]^2 \geq \frac{v}{C_F + R} [R - 1] - \frac{1}{2}\phi \left[\frac{v}{C_F + R} \right]^2.$$

The solution of the inequation is:

$$v \leq \bar{v}_-^M \vee \bar{v}_+^M \leq v,$$

with

$$\bar{v}_-^M = \frac{1}{\phi} [C_F + R] \left[[1 - \lambda] [C_F + R] + [R - 1] - \sqrt{[1 - \lambda] \left[[1 - \lambda] [C_F + R]^2 + 2 [C_F + R] [R - 1] \right]} \right],$$

which is irrelevant since $\bar{v}_-^M < \hat{v}^M$ and

$$\bar{v}_+^M = \frac{1}{\phi} [C_F + R] \left[[1 - \lambda] [C_F + R] + [R - 1] + \sqrt{[1 - \lambda] \left[[1 - \lambda] [C_F + R]^2 + 2 [C_F + R] [R - 1] \right]} \right].$$

However, since $v^{BB} < \bar{v}_+^M$ (it is easy to show), the parent bank never rescues if the multina-

tional regulator is in charge.

Assume that the home country regulator has the power of resolution. Then the parent bank bails out its subsidiary if $v \leq v^{BB}$ and

$$-v[1 - \lambda] + \pi(q^B) \geq \pi(q^{NH})$$

or, equivalently,

$$-v[1 - \lambda] + \frac{1}{2\phi} [R - 1]^2 \geq \frac{v}{R - 1} [R - 1] - \frac{1}{2}\phi \left[\frac{v}{R - 1} \right]^2.$$

Solving the inequation we obtain:

$$v \leq \frac{1}{\phi} [R - 1]^2 \left[[2 - \lambda] - \sqrt{[2 - \lambda]^2 - 1} \right] \vee \frac{1}{\phi} [R - 1]^2 \left[[2 - \lambda] + \sqrt{[2 - \lambda]^2 - 1} \right] \leq v.$$

Notice that the threshold is not binding if

$$v \leq \frac{1}{\phi} [R - 1]^2.$$

Since

$$\frac{1}{\phi} [R - 1]^2 \left[[2 - \lambda] - \sqrt{[2 - \lambda]^2 - 1} \right] < \frac{1}{\phi} [R - 1]^2,$$

the left side is irrelevant. From Lemma 24, we already know that the parent bank only rescues its subsidiary bank if

$$v < \frac{1}{2\phi} [R - 1]^2.$$

Hence, the parent bank rescues if

$$\frac{1}{\phi} [R - 1]^2 \left[[2 - \lambda] + \sqrt{[2 - \lambda]^2 - 1} \right] \leq v \leq v^{BB}.$$

However, since

$$\frac{1}{\phi} [R - 1]^2 \left[[2 - \lambda] + \sqrt{[2 - \lambda]^2 - 1} \right] > \frac{1}{2\phi} [R - 1]^2$$

for $\lambda \in [0, 1]$, the parent bank never restores its subsidiary bank if the home country regulator controls.

Proof of Proposition 26

If the parent bank has to inject θ , the relevant threshold level is:

$$\frac{v - \theta}{C_F + 1} =: \tilde{q}^H.$$

Assume that the host country regulator controls. Then the subsidiary bank chooses \tilde{q}^B

(notice that we are considering the case where the parent bank does not rescue) if

$$E + \frac{1}{2\phi} \lambda^2 [R - 1]^2 > \lambda E + [1 - \lambda] [E - \theta] + \tilde{q}^H [R - 1] - \frac{1}{2} \phi \left[\tilde{q}^H \right]^2$$

or, equivalently, if

$$\frac{1}{2} \phi \left[\tilde{q}^H \right]^2 - \tilde{q}^H [R - 1] + \frac{1}{2\phi} \lambda^2 [R - 1]^2 + \theta [1 - \lambda] > 0.$$

Solving the inequation leads to:

$$\begin{aligned} \tilde{q}^H &< \frac{1}{\phi} [R - 1] \left[1 - \sqrt{1 - \lambda^2 - 2\phi \frac{[1 - \lambda] \theta}{[R - 1]^2}} \right] =: \tilde{q}_-^H \\ &\vee \\ \tilde{q}^H &> \frac{1}{\phi} [R - 1] \left[1 + \sqrt{1 - \lambda^2 - 2\phi \frac{[1 - \lambda] \theta}{[R - 1]^2}} \right] =: \tilde{q}_+^H. \end{aligned}$$

We do not have to analyse the left side, as $\tilde{q}_{-, \theta=0}^H = \tilde{q}_-^H$ is not binding. For the right side, \tilde{q}_+^H , we have:

$$v > \theta + \frac{1}{\phi} [R - 1] [C_F + 1] \left[1 + \sqrt{1 - \lambda^2 - 2\phi \frac{[1 - \lambda] \theta}{[R - 1]^2}} \right] =: \tilde{v}_+^H.$$

It remains to check whether an increase in θ can increase the threshold level \tilde{v}_+^H . Differentiating \tilde{v}_+^H with respect to θ , we obtain:

$$\begin{aligned} \frac{\partial \tilde{v}_+^H}{\partial \theta} &= 1 - \frac{1}{\phi} [R - 1] [C_F + 1] \frac{2\phi \frac{[1 - \lambda]}{[R - 1]^2}}{2\sqrt{1 - \lambda^2 - 2\phi \frac{[1 - \lambda] \theta}{[R - 1]^2}}} \\ &= 1 - \frac{1}{\phi} [C_F + 1] \frac{\phi [1 - \lambda]}{[R - 1] \sqrt{1 - \lambda^2 - 2\phi \frac{[1 - \lambda] \theta}{[R - 1]^2}}}. \end{aligned}$$

An increase of θ leads to an increase of \tilde{v}_+^H at $\theta = 0$ if

$$\frac{[C_F + 1]^2 - [R - 1]^2}{[C_F + 1]^2 + [R - 1]^2} < \lambda.$$

Chapter 6

What Makes Banking Crisis Resolution So Difficult? Lessons From Japan and the Nordic Countries

6.1 Introduction

During the recent financial crisis, authorities intervened massively in the banking sector. They provided liquidity assistance as well as equity capital for distressed financial institutions, often in order to reduce the social costs of bank failures. In many cases, such financial assistance resulted in rising public budget deficits, which indicated a trade-off between stabilizing the banking industry and maintaining sound public finances. In some European countries, such as Ireland and Spain, bank bailouts even forced governments to ask for financial assistance from the European Union and the International Monetary Fund (IMF), showing that a banking crisis can often only be solved at the expense of an increasing risk of a sovereign debt crisis (Acharya, Drechsler & Schnabl (2011)).

While it is important, the fiscal burden is not the only dimension of a crisis resolution. When reacting to a banking crisis, regulators must also take into account the impact of their actions on social costs in terms of GDP loss and the consequences of their actions for future risk-taking behaviour of banks. Unfortunately, the relationship between fiscal burden, GDP growth, and bank risk-taking incentives is not clear-cut. The appliance of a cheap crisis resolution tool, such as granting guarantees, might not always be efficient from a risk (moral hazard) point of view. Therefore, policy-makers have to choose between the effects of resolution packages. This may not always be easy. In addition to conflicting goals, regulators may also face difficulties in implementing their preferred bailout policies. Such difficulties may result from transaction costs and coordination problems among authorities, such as sub-optimal allocation of responsibilities, and commitment problems.

Against this background, the aim of this paper is to identify which specific difficulties authorities face when choosing and implementing crisis resolution packages.¹ We review the literature on the effects of crisis resolution measures and analyse resolution paths in past crises. We ask three interrelated questions: Which trade-offs and obstacles do policy makers face when resolving a banking crisis? How did these difficulties shape the course of past banking resolutions, and what were the impacts of these instruments on moral hazard and fiscal costs? What lessons can be learnt from these experiences for future crisis resolutions?

We use the case-study method which allows us to cover contextual conditions. This approach is appropriate whenever the phenomenon studied and its context are not always distinguishable and when circumstances are highly pertinent to the phenomenon of study (Yin (2003)). This is, in particular, the case during a financial crisis when policy decisions which are made reflect potential conflicts of interest between different regulatory agencies or mirror potential opposition of groups with different vested interests against single rescue packages. As the present crisis is still persisting and repercussions from the ongoing sovereign debt crisis on bank failures are still possible, we do not choose the current crisis resolution as the main subject matter for our present study; rather, we consider completed crisis resolution episodes which, however, should also not date back too far in the past. We thus take the 1990s as our preferred period of observation.

We chose Japan and the Nordic countries as the subject matters for the following reasons: Firstly, both regions have suffered from the most serious financial and economic crisis experienced by advanced market economies since WWII. Secondly, economic crises in both regions came after a period of financial liberalization and happened within similar institutional contexts with great affinities to current circumstances; this allows us to transform some of the lessons learnt from past episodes to the current crisis. Finally, policy reactions are evaluated differently in the literature. While Japan is typically regarded as an example of a failed banking crisis resolution (Allen & Gale (1999); Kanaya & Woo (2000); Fujii & Kawai (2010); Hoshi & Kashyap (2010)), crisis resolution in the Nordic countries is generally considered as successful, in particular in Norway and (less) in Sweden and Finland (Ingves, Lind, Shirakawa, Caruana & Martínez (2009); Jonung (2009)).

This chapter proceeds as follows: Section 6.2 reviews the literature on the effects of banking crisis resolutions on banks' risk-taking, on direct fiscal/social costs, and on the policy trade-offs for politicians; moreover, it discloses restrictions which policy-makers face when resolving banking crises. Section 6.3 turns to the two regions under consideration and asks why particular instruments were taken and examines how political conflicts shaped crises resolution processes. Section 6.4 reassesses the crisis resolution packages applied during the recent financial crisis in light of the experience made in Japan and the Nordic countries during the 1990s. Section

¹Since our main interest is in crisis reaction mechanisms (after the breakout of the crisis), we do not discuss consequences for future crisis prevention; on this, see White (2008), Freixas (2010), Allen & Carletti (2010); Cukierman (2011); Vollmer & Wiese (2013). Political measures for crisis prevention have already been incorporated into the EU framework for bank recovery and resolution. See the proposal for the Bank Recovery and Resolution Directive (BRRD).

6.5 concludes this chapter.

6.2 Financial assistance, policy trade-offs and crisis resolution obstacles

6.2.1 Taxonomy

As shown in Table 6.1, financial assistance to troubled banks involves liquidity assistance by a lender of last resort (LLR) or/and solvency assistance measures ("bank bail-outs") by an owner of last resort (OLR). Liquidity assistance may be provided either by the central bank (CB) or by a deposit insurer (DI). It usually means the provision of liquidity to a single financial institution ("emergency liquidity assistance"; ELA) or to the financial market as a whole in the form of monetary easing or credit easing.² ELA could be provided at market interest rates or above market rates. Solvency assistance is usually provided by the Ministry of Finance (MoF) or, in exceptional cases, also by the CB. It includes instruments that either apply off the balance sheets (like guarantees to unsecured depositors or bank guarantees) or alter the banks' balance sheets. On-balance sheet instruments comprise a recapitalization through the liability side of the balance sheet (issuance of new equity or debt conversion into equity) or through the asset side of the bank's balance sheet (purchases of non-performing loans or "toxic assets" which are transferred to a 'bad bank' or cash injection). Transfer of assets and/or liabilities to a "bridge bank" may touch both sides of a troubled bank's balance sheet.

The need for liquidity assistance results from the fact that banks are possibly subject to a bank-run. Normally, interbank markets shield individual banks against idiosyncratic liquidity shocks because they allow banks to outweigh their individual liquidity deficits and surpluses (Bhattacharya & Gale (2011), Allen & Gale (2000)). During financial crises, however, interbank markets may fail and stop working smoothly because market participants perceive increases in counterparty risks or liquidity risks (Freixas, Parigi & Rochet (2000), Eisenschmidt & Tapking (2009), Heider, Hoerova & Holthausen (2010), Acharya & Skeie (2011), Vollmer & Wiese (2014)). Moreover, strategic actions of surplus banks may also result in a failure of interbank markets because banks with a liquidity surplus can benefit from low prices of assets which are fire-saled by illiquid banks and thus avoid liquidity injection to illiquid banks (Acharya, Gromb & Yorulmazer (2012)).

In contrast to the case for liquidity assistance, the case for public bank bailouts is less clear-cut. Solvency payments are not necessary in a setup of Modigliani & Miller (1958), and under the assumption that debt contracts can be renegotiated at any time because debt can be transformed into equity at no cost and the probability of default almost becomes zero (Landier & Ueda (2009); Dewatripont & Freixas (2011); Philippon & Schnabl (2013)). With

²Under monetary easing, the CB increases the size of its balance sheet and provides liquidity to the markets above the benchmark allotment. Under credit easing, the CB alters the structure of its balance sheet towards riskier/longer-term assets.

Table 6.1: Forms of public financial assistance to troubled banks

| Liquidity assistance | | | | | |
|--------------------------------------|------------------|---|-----------------------------|------------------------------|----------------|
| to single banks (ELA) | | | to the market | | |
| at market interest rate | at penalty rates | | monetary easing | | credit easing |
| Solvency assistance ("bank bailout") | | | | | |
| off-balance sheet | | through the liability side | | through the asset side | |
| guarantees to unsecured depositors | bank guarantees | new equity | debt conversion into equity | asset transfer to a bad bank | cash injection |
| | | asset and liability transfer to a bridge bank | | | |

informational asymmetries, however, the independence of the bank value from the structure of the liability side of the bank's balance sheet does not hold anymore; debt renegotiations may also be impossible due to the dispersion and the large number of creditors (Gilson, John & Lang (1990); Landier & Ueda (2009)). In consequence, a bank might become subject to an insolvency shock, i.e. to the risk that capital buffers are insufficient to cover losses.

Private bailouts may form an alternative to the provision of public assistance to failed banks, but may be feasible only when the number of insolvent institutions is not too large (Acharya & Yorulmazer (2007)). Under private bailouts, costs are borne by private owners of acquiring banks rather than by tax payers. Moreover, private bailouts may increase the value of acquiring banks, which may, in general, induce banks to behave more prudently (Perotti & Suarez (2002)). The drawback, however, is that bank acquisitions may reduce competition on markets for banking services. The effect of reduced competitiveness on risk-taking is ambiguous because it may reduce funding costs, but also increase loan rates (Boyd & De Nicoló (2005)). High loan rates increase the banks' margin and thus reduce their risk-taking, but they also influence bank customers' risk-taking and thus their probability of repayment (Martinez-Miera & Repullo (2010)).

6.2.2 Liquidity provisions

Liquidity assistance to single banks reduces banks' incentives to hold liquidity because such liquidity support increases the resale value of assets (Acharya, Shin & Yorulmazer (2011)). Concerning the provision of liquidity at or above market rates, Bagehot (1873) argued that the Bank of England should lend against collateral any amount to an illiquid, but solvent

institution only at a penalty rate.³ In that case, however, a bank may increase its risk-taking because penalty rates decrease the bank's margin and thus may create incentives to gamble (Repullo (2005)). The influence of penalty rates on banks' risk-taking may also depend on whether the shocks hitting the banks are caused by the banks themselves. When the bank managers' effort reduces the likelihood of large and intermediate shocks (that cause solvency and illiquidity problems as well) penalty rates increase banks' incentives to remain liquid. By contrast, if the bank managers' effort only reduces the likelihood of large shocks, penalty rates have a negative effect on the banks' effort to remain liquid (Castiglionesi & Wagner (2012)). Liquidity assistance to single banks may not only affect banks' risk-taking behaviour but also cause higher fiscal costs, in particular if the liquidity support to financial institutions lasts a longer period of time and thus becomes similar to solvency support (Honohan & Klingebiel (2003)).

The impact of monetary and credit easing on risk-taking depends on the capital structure and leverage of banks. With a fixed capital structure, monetary easing increases risk-taking if banks are highly capitalized; if their capitalization is small, banks reduce their risk-taking. The reason for this is that monetary easing has two different effects on the risk-taking of banks. Firstly, monetary easing reduces the interest rate which, in turn, diminishes the banks' return on loans. This "revenue effect" decreases the banks' incentives to monitor their borrowers, i.e. increases risk-taking. Secondly, monetary easing reduces the banks' funding costs which prevents them from increasing their risk ("cost effect"). In the case of a fixed capital structure, low capitalized banks lower their risk-taking if monetary easing is applied because the "cost effect" dominates the "revenue effect". If the capital structure is not fixed, monetary easing increases banks' risk-taking. As monetary easing reduces a bank's benefit of a high capital base, i.e. lower debt costs, banks lower their capital base. Banks with high leverage, however, have lower incentives to survive, as they risk losing less (Laeven, Dell'Ariccia & Marquez (2010)).⁴

6.2.3 Bank bailouts

In the Modigliani-Miller setup, in particular under symmetric information, and under the assumption that debt renegotiation is impossible, both on-balance sheet and off-balance sheet interventions can increase a bank's stability. In either case, however, the regulator has to transfer assets to shareholders in order to make them willing to accept these measures. The required compensation is higher in the case of subsidized asset sales than in the case of asset guarantees and recapitalizations because debt recovery is higher, which in turn increases the

³For a review of the early literature on liquidity provision and bank risk-taking, see also Freixas, Giannini, Hoggarth & Soussa (2000).

⁴For empirical evidence concerning the impact of short-term interest rates on banks' risk-taking incentives, see Jiménez, Ongena, Peydro & Saurina Salas (2009), Ioannidou, Ongena & Peydro (2009), Altunbas, Gambacorta & Marqués-Ibáñez (2010) and De Nicolò, Dell'Ariccia, Laeven & Valencia (2010).

debt value more (Landier & Ueda (2009)).⁵ Philippon & Schnabl (2013) show that under symmetric information a share in a bank's assets, the purchase of equity shares and the issuance of debt guarantees lead to the same costs for the government.⁶

In the case of asymmetric information, i.e. outside the framework of Modigliani-Miller, off-balance sheet interventions, such as blanket guarantees for the survival of banks, can have a risk-reducing effect, too, because a higher bailout probability increases a bank's charter value, which induces it to behave more prudently.⁷ This "value effect" outweighs the "moral-hazard-effect" if the regulator can credibly commit himself to a policy which promises a bailout only in times of macroeconomic distortions and a liquidation otherwise (Cordella & Yeyati (2003)). Due to the fact that the occurrence of these conditions is uncertain, such a bailout policy can be considered as "constructive ambiguity".

Apart from guarantees for banks and their shareholders, a regulator may also guarantee the payoff of unsecured depositors with two effects on banks' risk-taking. Both result from the fact that the guarantees for unsecured depositors decrease the risk premium banks have to pay to their depositors. This, on the one hand, increases the banks' net profit and raises the banks' incentives to behave prudently ("margin effect"). On the other hand, a lower risk premium induces banks to increase their deposit volume. A higher deposit volume raises deposit rates which, in turn, causes higher risk-taking ("volume effect"). Whether the "margin effect" outweighs the "volume effect" depends on the elasticity of deposit demand. If this elasticity is large, a small increase in deposit rates sharply increases the deposit volume. Then banks receive the deposits cheaply and the "margin effect" dominates the "volume effect", i.e. banks decrease their risk-taking. By contrast, if the elasticity of deposit demand is low, banks have to offer "very" high deposit rates in order to increase their deposit volume. Then the "volume effect" dominates and banks increase their risk-taking.

Moreover, bank bailouts do not only affect the risk-taking of the protected bank, but also that of its competitors. Since bailout guarantees induce the secured bank to expand, aggregate deposit rates increase. This, however, lowers the margins of the competitor banks and thus induces them to increase the competitor bank's risk level (Hakenes & Schnabel (2010); Gropp, Hakenes & Schnabel (2011)). Even though the protection of banks' depositors and creditors may decrease the risk-taking of the protected bank, it tends to increase fiscal costs of banking crises (Honohan & Klingebiel (2003)). However, debt guarantees are in general less costly than the injection of free cash because the government only pays out the insurance if the bank defaults while under free cash injection, the government always pays out cash. Moreover, all banks participate in the free cash injection, i.e. also healthy banks which do not all participate

⁵This arises from the fact that interventions, which reduce the probability of default, increase the recovery value of debt. Since the bank value remains constant in the Modigliani-Miller setup, a higher debt recovery involves a lower value for shareholders. Thus, they do not have incentives to agree with these kinds of interventions unless they are compensated by a regulator, for example.

⁶Purchases of shares in a bank's assets and purchases of equity shares differs in such a way that the latter provides a share in the bank's assets and investment opportunities.

⁷In this framework, all depositors are secured by a deposit insurance. A bank bailout enables the bank (the shareholders) to generate a charter value.

in the debt guarantee program (Philippon & Schnabl (2013)).

Proceeding with on-balance sheet interventions, Berger, Bouwman, Kick & Schaeck (2012) find empirical evidence from the German banking sector that capital injections reduce the risk-taking of the protected bank and its competitor bank in the short-run and in the long-run. Differentiating between common equity injection and preferred equity injection, Wilson & Wu (2010) show that the former is at least as efficient as the latter with regard to preventing banks from gambling. However, capital injection through the purchase of preferred stocks or the issuance of subordinated debt in exchange of warrants may limit the participation by banks that do not require recapitalization. This is a key driver for the "fact" that the purchase of equity shares leads to lower costs to the government than debt guarantees and the purchase of shares of a bank's assets. In the latter case, the costs to the government are the highest (Philippon & Schnabl (2013)). Duchin & Sosyura (2013) provide empirical evidence for the U.S. banks during the recent crisis that public recapitalization by the issuance of preferred shares increased banks' risk-taking. Differentiating between small and large banks, Black & Hazelwood (2013) find that the provision of capital for the U.S. banks during this time increased the risk-taking of large banks, but decreased loan risk-taking of small banks.⁸ Recapitalizations, however, in particular repeated recapitalizations rather increase fiscal costs of banking crises (Honohan & Klingebiel (2003)).

Debt conversion into equity may be an alternative to restructure the liability side of the bank. Such contingent capital, however, raises incentives to take higher risks, especially in the case of low equity capital (Pennacchi (2010)). Apart from contingent capital, banks can be forced to issue subordinated debt. The impact of subordinated debt of banks' risk-taking is ambiguous. Niu (2008) argues that it may reduce banks' risk-taking, while Pennacchi (2010) shows that moral hazard may increase and even be higher than in the case of contingent capital. However, in both cases, the burden of these debt transformations is not borne by tax payers but by the banks' former debt holders and capital owners. Apart from forcing the bank to convert debt into equity, the regulator can force a bank to issue equity if a pre-defined solvency trigger level has been reached. This may encourage banks to remain solvent (Hart & Zingales (2011)).

Besides recapitalization through the liability side, restructuring can also take place in the form of cash injection or asset sales to the government (or private investors). The impact of cash injections on banks' risk-taking may depend on whether the cash provision is unconditional or not. Granting unconditional support, i.e. lump-sum transfers, does not increase banks' risk-taking; however, it can be quite expensive for the government and tax-payers cannot participate in future upside gains. By contrast, if these interventions are conditional on, e.g. the start of a new business line, banks can externalise risks and this increases their risk appetite (Dietrich & Hauck (2012)). As an alternative to cash injections, bank assets can be sold, for instance, to

⁸Duchin & Sosyura (2013) Black & Hazelwood (2013) analyse for the U.S. the relation between capital injection and risk-taking in the course of the Troubled-Asset-Relief-Program (TARP). Initially, the TARP was launched to purchase troubled assets in order to stabilize the U.S. financial system. However, a short time after, the Capital Purchase Program (CPP), as part of the TARP, was unveiled.

private sector institutions. If this increases the acquiring banks' market power, banks have an incentive to remain solvent *ex ante* (Perotti & Suarez (2002)). The effectiveness of asset sales to prevent banks from risk-taking may even be higher than the issuance of preferred shares, but lower than the issuance of common equity shares (Wilson & Wu (2010)). However, the purchase of assets can be quite difficult, as it is sometimes hard to evaluate these assets.

Instead of separating "bad assets", the regulator can assist the bank in separating "bad liabilities" and transfer all of the assets as well as the senior liabilities to a new bridge bank (Bulow & Klemperer (2009)). Since junior creditors and shareholders of the old bank bear all of the losses, market discipline is ensured and moral hazard among shareholders is avoided. The transfer of liabilities still opens the possibility of subsidizing junior debtholders in order to avoid a run.

6.2.4 Crisis resolution obstacles

Different countries may choose different crisis resolution packages for two different reasons: different political preferences with respect to the consequences of the packages (risk-taking; fiscal costs; social costs) or different political and/or institutional restrictions. The chosen rescue packages reflect preferences only if the conditions of the "political Coase theorem" (PCT, Acemoglu (2003)) are fulfilled. The PCT follows the idea of the original Coase theorem, which states that, as long as property rights are well-defined and there are no transaction costs, economic agents will conclude contracts with efficient outcomes, regardless of the distribution of property rights. Acemoglu (2003) extends this idea from the market sphere to the political sphere and describes the PCT as the idea that "political and economic transactions create a tendency towards policies and institutions that achieve the best outcomes given the various needs and requirements of societies, irrespective of who, or which social group, has political power." He confronts this idea with "theories of social conflict" according to which societies choose different policies because of decisions made by powerful social groups that are interested in maximizing their own payoffs, not social welfare.⁹

Underlying the political Coase theorem are the assumptions that (i.) the rights to make political decisions are well-allocated, that (ii.) transaction costs are low, and that (iii.) contracts between political actors are enforceable and not disturbed by a political commitment problem. If these conditions are not fulfilled, policies chosen will neither represent voters' preferences nor maximize social welfare, but reflect the preferences of politicians or politically powerful social groups. Among these assumptions, the absence of enforcement problems and of political commitment problems is of special importance, because contracts that the state would like to write with others will not be enforceable by definition. Since the state can always

⁹Acemoglu (2003) applies PCT to policies as well as institutions, i.e. to the choices made within a given framework and to the choice of the framework itself. Since institutions change only gradually, we restrict ourselves to the choice of policies. Moreover, Acemoglu (2003) also considers a "modified PCT" according to which societies choose different policies because of different choices made by leaders taken under uncertainty.

use its powers to renege on the contract and cannot commit itself to keep to the terms of contract, the potential to reach efficient outcomes is undermined.

The difference between preferences and political/institutional restrictions is not always clear-cut, but time-dependent. A factor which constitutes a restriction to the availability of a crisis resolution measure in the short-run may form the result of a political preference in the long-run. A case in point is an exchange rate peg which limits the CB's ability to change interest rates in reaction to a financial crisis or forces the domestic authorities to subsidize foreign bank creditors by declaring blanket guarantees on deposits. However, taking a broader time-horizon into account, the currency peg is the outcome of political preferences. Henceforth, we consider political and institutional obstacles in the point of time when resolution decisions have to be implemented.

In the case of banking crisis resolution, the following constraints may in particular shape the choice of the resolution package:

- Suboptimal allocations of responsibilities between institutions which may either act as an LLR or as an OLR, such as the CB, on the one hand, and the deposit insurer (or the Ministry of Finance), on the other hand: In case of a liquidity shock, the allocation of LLR responsibilities matters, as both types of institutions may react differently to a bank's liquidity needs because they pursue different goals. As long as liquidity assistance is not allocated ex ante between both types of institutions, discretionary and non-coordinated liquidity assistance may result in the LLR being either "too strict" or "too soft", i.e. refusing liquidity assistance when it should be provided or providing liquidity assistance when it should be refused (Repullo (2000); Kahn & Santos (2005); Hauck & Vollmer (2013)).
- Transaction costs may complicate the assignment of single crisis resolution instruments, such as bank resolutions and bank nationalizations. Without a complete description of a bank's financial and non-financial activities in normal times and in crisis scenarios ("living wills"), it may be very difficult for authorities to accurately value the assets of complex and large banking firms. Consequently, the transfer of assets to a bad bank or a bridge bank may be impossible and the authorities thus have no other choice but to support such a bank under financial pressure. In addition, information costs make it difficult to differentiate between solvent and insolvent institutions, especially in a short period of time (Goodhart (1999)). Finally, if a bank defaults, financial assistance by the Ministry of Finance or a deposit insurer may be difficult to organize at short notice because they usually lack funds. In contrast, liquidity provision by the central bank is relatively easy to get, even if this means that the CB takes over additional risks on its balance sheet.
- Commitment problems arise for authorities providing liquidity assistance or/and equity capital as well. In the case of an LLR, providing liquidity only at a penalty rate, i.e. at

an interest rate higher than the market rate, may be time inconsistent if it aggravates the bank's solvency problem. It may also send signals to the market participants that the bank is in trouble; fears of stigmatization make banks reluctant to apply for funds because they fear to be singled out as a weak institution (Dewatripont, Rochet & Tirole (2010)). Commitment problems also exist in the case of liquidity provision to the market. If the CB can commit itself ex ante not to lower interest rates ex post, banks are deterred from investing in risky assets, as they anticipate not to be bailed out by low interest rates. By contrast, if the CB cannot make such commitments, banks expect to be bailed out by low interest rates, which induces them to invest in risky assets. Consequently, many banks will be distressed ex post and the CB finds it optimal to bail them out by lowering interest rates (Farhi & Tirole (2009)). Finally, commitment problems can also exist for an authority deciding to resolve an insolvent institution. The authority's announcement to close a bank may lose credibility if the bank is too large ("too big to fail"), the number of bank failures is large ("too many to fail"), or if the failing banks have become too complicated to be resolved ("too complicated to fail"). In all cases, the regulator may find it ex-post optimal to bail out some or all failed banks if bailout costs are smaller than social costs caused by liquidation (Mailath & Mester (1994); Acharya & Yorulmazer (2007); Acharya & Yorulmazer (2008); DeYoung, Kowalik & Reidhill (2013)).

Under these conditions, policy makers might be forced to apply inferior crisis resolution packages which do not perfectly match with voters' preferences. The task of the following section is to identify the forces that prevent an efficient choice of policies and to reveal those variables which hinder societies from implementing an efficient banking crisis resolution scheme. As mentioned in the introduction, we take Japan and the Nordic countries during the 1990s as two natural experiments.

6.3 Banking crisis resolution in Japan and the Nordic countries

6.3.1 Japan

Before the breakout of the crisis, financial markets in Japan were heavily regulated by the MoF and closely surveyed by the Bank of Japan (BoJ).¹⁰ Due to interest rate caps, portfolio regulations, and capital controls, competition in the banking sector was limited and security markets were underdeveloped (Takeda & Turner (1992); Ueda (1994)). Financial deregulation in Japan started during the 1970s due to international pressures and to growing public sector

¹⁰For thorough surveys of banking regulations and the political reactions to the financial crisis in Japan, see Nakaso (2001); Fukao (2000); Fukao (2003); Bebenroth, Dietrich & Vollmer (2009); Hoshi & Kashyap (2000) Hoshi & Kashyap (2010). The appendix provides an overview of the main interventions.

budget deficits after the second oil shock. Financial sector reforms were accompanied by monetary easing by the BoJ, which decreased interest rates to avoid an appreciation of the Yen against the Dollar (Yoshino (1996); Nakaso (2001); Takeda & Turner (1992)). Banks reacted to financial deregulation and monetary easing by lending an increasing fraction of their assets to small- and medium-sized firms and to the real estate sector as well, which increased banks' risk level (Hoshi & Kashyap (2000)). In consequence, real estate prices started to rise until the early 1980s, when the BoJ tightened monetary policy. This caused a decrease in lending growth and a drop in asset prices and hence in the collateral value of loans (Takeda & Turner (1992); Fukao (2000); Fukao (2003)).

In 1991, the Japanese banking sector experienced sporadic failures of smaller institutions, which were initially regarded as rather isolated events. Public intervention became necessary, however, when two urban deposit-taking institutions, "Tokyo Kyowa" and "Anzen", failed in December 1994. Because of fears of contagion, authorities refused to apply a haircut on deposits, which was mandatory due to a "payoff cost limit" set by law.¹¹ They, instead, decided to provide financial assistance and to cover all accumulated losses. A "bad bank" scheme was introduced and assets and liabilities of the two failed institutions were transferred to "Tokyo Kyoudou Bank" (TKB), a new bank jointly established and recapitalized by the BoJ with participation of almost all private financial institutions.¹² The former shareholders of the failing banks were squeezed out and the management was removed in order to prevent moral hazard (Nakaso (2001)).

In July 1995, three medium-sized banks, "Cosmo Credit Cooperative", "Hyogo Bank" and "Kizu Credit Cooperative", failed. In the case of "Cosmo" and "Hyogo" assets and deposits were transferred to TKB and Midori Bank, respectively, and both banks were dissolved. In the interim period both banks received liquidity assistance in order to be able to continue their daily business. In the case of "Kizu Credit Cooperative", private institutions refused to provide financial support because they feared that a series of financial contributions would erode their own financial soundness. Instead, they urged a reform of the Deposit Insurance Law and a lifting of the payoff cost limit, which was abandoned in 1996. In addition, the risk premium for the deposit insurance fee was increased and the Tokyo Kyodou Bank was reorganized into the "Resolution and Collection Bank" (RCB; later: "Resolution and Collection Corporation" RCC). It received the role of a "bank of last resort", being able to absorb non-performing loans or even the whole business of failed institutions (Nakaso (2001)).

In early 1997, the Japanese banking crisis became more severe with the bankruptcy of the first major city bank, "Hokkaido Takushoku Bank", and the financial distress of "Nippon Credit Bank" (NCB), one out of three long-term credit banks in Japan (Hoshi & Kashyap

¹¹The payoff cost limit was a limit to the amount of financial assistance the Japanese Deposit Insurance Company (DIC) could legally offer in any single case. It was defined as the insured deposits times the loss ratio where the loss ratio was the part of liabilities which was not covered by sound assets (Nakaso (2001)).

¹²Participation by private institutions was voluntary. According to article 25 of the Bank of Japan Law, the BoJ was authorized to provide liquidity support and to inject risk capital into distressed banks as well (Nakaso (2001)).

(2010)). Both institutions suffered from solvency problems and needed capital injections in excess of the financial capacity of the DIC. In the case of “Hokkaido Takushoku Bank”, the MoF first organized a private sector solution and asked large shareholders (mainly insurance companies) and the “Industrial Bank of Japan” as well as the “Long Term Credit Bank of Japan” for capital injections. Since this rescue plan turned out to be infeasible, related financial institutions and the BoJ injected new equity capital in the form of preferred shares which could be converted into common shares (Hoshi & Kashyap (2010)). “Hokkaido Takushoku Bank” was finally merged with “Hokkaido Bank” and with “Chuo Trust and Banking Company”, and in the interim period the BoJ provided liquidity assistance to outweigh deposit withdrawals.

A private sector solution was also tried. It was to be implemented for NCB, but it soon turned out that the financial contributions given by large banks and other related parties were too small to provide a solid capital basis for NCB. The BoJ had to inject additional funds (in the form of preferred stocks) into NCB. Although NCB was at first saved, its asset value deteriorated quickly and the bank was nationalized in December 1998, after the capital, which had already been injected, was completely lost (Nakaso (2001)).

In early November 1997, “Sanyo Securities”, a medium-sized security house, failed and suspended its business. The BoJ did not provide bilateral financial assistance because “Sanyo” did not take deposits or offer settlement services to non-banks and was not regarded as being systemic. However, “Sanyo” was a borrower on the interbank market and the BoJ underestimated the increase in risk sensitivities following from the default on unsecured interbank markets. Interest rates on unsecured interbank loans increased substantially, and in late November 1997, the BoJ massively injected liquidity into the markets. At that time, “Yamaichi Securities”, one of the largest Japanese security trading companies, failed and the BoJ now provided individual liquidity support in order to allow “Yamaichi” to continue its business and to settle all existing contacts. Such an orderly wind-down was executed to avoid a negative spillover to the banking sector and a breakdown of the interbank market (Nakaso (2001)).

By the end of 1997, more bank failures were announced, among them the failure of “Tokyo City Bank”, a regional bank based in Sendai. Although “Tokyo” was not regarded as systemic, its failure destroyed depositors’ trust mainly in other regional banks, and depositors started to queue in front of them. To prevent bank runs and contagion, the BoJ declared a blanket guarantee on all deposits (including interbank deposits) and the government decided to use public funds to stabilize the financial system. In February 1998, the “Financial Function Stabilization Act” was passed, which allowed the government not only to pay out depositors but also to recapitalize banks. A newly created “Financial Crisis Management Committee” became responsible for selecting eligible banks. In March 1998, all major banks jointly applied for public capital, but asked for only very small amounts, which was mainly provided in the form of subordinated loans and bonds, and most of the money was left unused (Fukao (2000); Fukao (2003); Nakaso (2001); Hoshi & Kashyap (2010)).

In mid-1998, the “Long-Term Credit Bank of Japan” (LTCB) collapsed. This bank had provided a variety of financial services and hence was of systemic importance. The BoJ did not

provide liquidity as an LLR because it feared that this would have a negative "announcement effect", cutting off LTCB's access to interbank loans. In order to attain an orderly wind-down of LTCB, the "Financial Reconstruction Law" was passed in October 1998 by the National Diet, which enabled the temporary nationalization of insolvent deposit financial institutions. On this basis, the LTCB was nationalized and later sold to private investors; business operations of the bank continued and all existing payment obligations were honoured. The bank management was replaced and existing shareholders had to cover losses (Fukao (2000); Nakaso (2001)).

Furthermore, the newly created "Financial Supervisory Agency" (FSA) took over supervisory powers from the MoF in June 1998. The FSA became subordinated to the "Financial Reconstruction Commission" (as the successor of the former Financial Crisis Management Committee) which now had the authority to inspect and supervise banks and to use information gathered by FSA. The newly enacted "Financial Function Early Strengthening Law" allowed the Financial Reconstruction Commission to recapitalize solvent banks which had lost confidence of investors and depositors and were facing difficulties in raising capital in the market on their own (Fukao (2000)). The amount available for bank recapitalizations was considerably enlarged and was considered to be large enough to leave banks with sufficiently high capital ratios even after non-realized losses had been deduced. The RCC also obtained the capacity to buy bad loans not only from failed banks, but also from those which were still solvent (Nakaso (2001)).

In order to restore confidence in the financial system, the government purchased mostly convertible preferred shares and subordinated debt in 1999. These capital injections were used by almost all banks. Banks which received public capital had to submit "management improvement plans" on how to improve profitability (Nakaso (2001)). The recapitalization in 1999 stabilized the financial markets, though the problem of non-performing loans and the undercapitalization persisted (Hoshi & Kashyap (2010)). However, as noted by Hoshi & Kashyap (2010), the nature of non-performing loans has changed since 2000. While during the 1990s banks herded by collectively lending to the real estate sector, lending to small and medium-sized enterprises became particularly important after 2000. Banks tended to overstate the quality of their loan portfolios, which were in large parts non-performing. Instead of writing off their book values or providing adequate provisions, banks tended to extend their loans to insolvent borrowers in order to conceal their losses from outsiders. Banks, in fact, pursued "zombie lending" or "evergreening" in order to hold down risk premiums for interbank lending and to retain access to interbank markets. They kept alive enterprises and thus contributed to the bad growth record of the Japanese economy during the next decade (Peek & Rosengren (2005); Caballero, Hoshi & Kashyap (2008)).

6.3.2 Nordic countries

Similar to Japan, financial markets in the Nordic countries were heavily regulated before the outbreak of the crisis.¹³ Bank credit flows were controlled and there was a cap on interest rates for bank loans (Vale (2004); Englund & Vihriälä (2009)). Banks focused on capturing market shares mainly by expanding in new geographical areas. In particular, in Norway, the banks focused on lending into the oil-related business and were severely hit by the drop of the oil price in 1985, which changed the economic environment. The oil price decline stopped the boom period, and the Norwegian current account changed from a surplus into a deficit, putting pressure on the Norwegian Krone (Knutsen & Lie (2002); Vale (2004)). Interest rate increases, following the German reunification, enforced an economic downturn in all three Nordic countries. In addition, Finland also suffered from the collapse of the Soviet Union, which turned down Finnish trade (Jonung et al. (2008)).

Norway

The Norwegian banking crisis began, one year before the crises in Sweden and Finland, with the failure of a medium-sized commercial bank in 1988. Until 1990, 13 small and medium-sized regional banks also failed, but they were too small to worry about systemic risks (Vale (2004)). Apart from liquidity support by the Norwegian Central Bank (“Norges Bank”), bailouts by mergers and acquisitions of larger solvent banks were sufficient to avoid a collapse of the banking system (Sandal (2004)). Acquisitions were supported by the banking industries’ private guarantee funds, the “Commercial Banks’ Guarantee Fund” (CBGF) and the “Savings Banks’ Guarantee Funds” (SBGF).¹⁴ These funds paid out deposits, but also issued loan guarantees against other liabilities of the failed bank in order to make a takeover attractive for an acquiring bank (Vale (2004); Wilse (2004)).

The private sector solution reached its limits at the end of 1990, when the crisis hit the larger banks and both private guarantee funds were neither able to inject enough capital nor to assure repayments of deposits in case of bank failure (Sandal (2004)). As private investors became reluctant to provide financial assistance (Vale (2004)), two government-sponsored guarantee funds, the “Government Bank Insurance Fund” (GBIF) and the “Government Bank Investment Fund” (GBF), were established in March 1991 in order to guarantee deposits and to inject capital into banks.

The GBIF at first extended loans to the two private guarantee funds (which invested equity capital into ailing banks); after October 1991, the GBIF directly injected capital into distressed banks under conditions, such as writing off of shareholder value, replacement of the management and restrictions on bank activities (Vale (2004); Sandal (2004)). These

¹³For surveys of the deregulation and crisis period in the Nordic countries, see Englund & Vihriälä (2009); Drees & Pazarbasioglu (1995); Jonung, Kiander & Vartia (2008); Vale (2004). See also the appendix.

¹⁴Although both funds were not state-funded, representatives from the “Banking, Insurance and Securities Commission (BISC)” and from the Norges Bank were members of their boards.

obligations were supposed to induce the banks' managements to search for alternative solutions before demanding public support and to avoid creating competitive advantages for rescued banks (Sandal (2004)).

The GBF ought to aid banks which were still solvent and which were not yet in trouble, but had difficulties in attracting private investors on their own; the GBF could only inject capital conjointly with private investors (Sandal (2004); Wilse (2004)). An amendment of the "Commercial Banking Act" enabled the government to write off shares of old shareholders against losses in order to make sure that they bore the losses before public interventions became necessary. The responsibilities allocated to the public funds and the Norges Bank were clear-cut. Both the GBIF and the GBF acted as OLRs; in addition, the central bank acted as LLR for individual banks with liquidity problems (Sandal (2004)).

In 1991, two more systemically relevant banks, "Christiania Bank" and "Fokus Bank", failed, and the crisis in Norway became systemic. In reaction, the public GBIF and the private CBGF injected capital (in the form of preference shares) into the distressed banks. The Norwegian government exercised its right to write off the old shares to zero before injecting fresh capital. Moreover, in 1991 and 1992 the GBIF also provided preference capital for the largest commercial bank, "Den norske Bank", before injecting ordinary share capital in 1993. Board members and members of the top management were replaced. In 1992, further loans were granted from GBIF to the SBGF, which in turn injected share capital into two banks, "Sparebanken Rogaland" and "Sparebanken Midtnorge" (Witse (2004)).

At the end of 1992, Norway de-pegged the krone (against the ECU), enabling the central bank to reduce interest rates. The peg of the krone against the ECU made the decrease of interest rates impossible. Consequently, the banking sector recovered quickly due to the improved performance of the economy; lower interest rates increased the collateral value of banks' customers and decreased their default rate (Witse (2004)). In 1993, "Christiania Bank" managed to increase its capital and to attract private investors, but the government remained a shareholder (through the GBF) until 2000 (Witse (2004)). Also in 1993, the GBIF converted its preferred capital shares of "Den norske Bank" into ordinary shares, which were partly sold at the beginning of 1994. The GBIF sold its remaining shares of "Den norske Bank" in 2001 (but the government remained the largest shareholder). The remaining shares of "Fokus Bank" and "Christiania Bank" were sold in 1995. The government-owned banks can be seen as "bridge banks" between the failed institutions and the privatizations (Vale (2004)). However, as only the shareholder structure of these banks changed, these were not bridge banks in the strict sense that liabilities and assets were transferred to another bank.

The quick and extensive policy reactions by Norwegian authorities managed to overcome the crisis swiftly and enabled the largest banks to keep operating in the international markets (Allen & Gale (1999)). Commercial and savings banks regained profitability in 1993 (Vale (2004)).

Sweden

At the end of 1991, two out of six major Swedish banks, "Första Sparbanken" and "Nordbanken", incurred large loan losses. While in the case of the state-owned bank "Nordbanken" the government injected new equity, the state provided loan guarantees for "Första Sparbanken" (Drees & Pazarbasioglu (1995); Sandal (2004)). However, at the beginning of 1992, this support turned out to be insufficient and the government bought all outstanding shares of "Nordbanken" and transferred the non-performing loans to a bad bank. In order to stabilize these institutions, both banks were supported by equity capital issued by the state (Drees & Pazarbasioglu (1995)). The state-ownership may have been one reason for the subsidy passed to private minority shareholders who received a higher price for their shares than the market price (Sandal (2004); Englund & Vihriälä (2009)). In 1992, "Gota Bank", another major Swedish bank, revealed solvency problems. The problems were solved in the same way as in the case of "Nordbanken". The "bad assets" were sold to another bad bank, whereas the performing assets were left in the "Gota Bank". Moreover, both the bad bank and the healthy part of "Gota Bank" received further capital from the state (Sandal (2004)).

When macroeconomic distortions became larger in autumn 1992, the crisis was treated as a systemic crisis. Ad hoc measures were not regarded as suitable interventions to restore stability of the banking sector (Drees & Pazarbasioglu (1995); Sandal (2004)). Moreover, confidence in the Swedish financial system was low. This caused a large outflow of foreign funds on which the Swedish economy heavily relied. To restore confidence, a blanket guarantee by the government was announced which protected all bank creditors (Ingves & Lind (1996); Englund (1999)). In order to avoid a conflict of interest, rescue operations were assigned to a newly created "Bank Support Authority" (BSA), which received an open-ended funding (Drees & Pazarbasioglu (1995); Ingves & Lind (1996); Jonung (2009)). The authority was established to provide and to coordinate public support for the ailing banks.¹⁵

In order to increase the efficiency of support, banks were assigned to one of three categories (Ingves & Lind (1996)). Banks in the first category – institutions with capital (at least slightly) above the minimum threshold of eight per cent – were encouraged to find a solution from the private sector to ensure solvency, and the BSA was to assist by temporarily providing guarantees. The second category consisted of banks which temporarily breached the capital requirements, but which might be able to meet these requirements in the long run. The BSA was prepared to inject capital into these banks or provide loans if private sector solutions were impossible. Banks from the third category were not able to fulfill capital requirements in the long run. These banks were to be either liquidated or merged or their assets sold to "bad banks".

Apart from "Gota Bank" and "Nordbanken", other banks, such as the largest Swedish banks, "S-E-Banken", "Swedbanken", "Foreningsbanken" and "Sparbanken Sverige", applied

¹⁵Its funding was open-ended to avoid political misgivings about the commitment to support the banking system (Jonung (2009)).

for capital support (Drees & Pazarbasioglu (1995)). However, a few months later, "Swed-banken" and "S-E-Banken" did not have to rely further on the support by the BSA, as their owners injected further capital (Ingves & Lind (1996)). The major part of the capital support was provided to the first two banks (Drees & Pazarbasioglu (1995); Sandal (2004)). In 1993, "Gota Bank" was taken over by the state-owned bank "Nordbanken" (Sandal (2004)).¹⁶

The central bank, Riksbanken, used a large share of its foreign currency reserves as liquidity support through currency deposits in the banks. Moreover, banks could borrow Swedish krona freely without security in Riksbanken's normal liquidity system (due to the government blanket creditor guarantee, Riksbanken faced no credit risk). These measures resolved the immediate liquidity problems (Sandal (2004)).

The improvement of the banks' financial position went in line with the overall macroeconomic recovery. The depreciation of the Swedish currency, the decrease of interest rates and the reduction of government deficit supported the banks' recovery process (Ingves & Lind (1996)). Public measures were supported throughout all political parties, which contributed to the credibility of the rescue programme and enabled the government to take actions immediately (Sandal (2004); Jonung (2009)).

Finland

The Finnish banking crisis began in 1991 when "Skopbank", a central institution mutually owned by the Finnish savings banks, could not meet the goals of the restructuring programme which had already begun at the end of the 1980s when the bank had been put under special and strict surveillance by the Bank of Finland and the Banking Supervision Office (Nyberg & Vihriälä (1994); Englund & Vihriälä (2009)). Skopbank was taken over by the Bank of Finland, which initially acted as an OLR because of the lack of alternative resources (Sandal (2004); Honkapohja (2009)); the bank was restructured by the setup of three companies which managed substantial portions of the assets of the bank. The board members of "Skopbank" were, to a large extent, replaced (Nyberg & Vihriälä (1994)).

In 1992, the state-funded "Government Guarantee Fund" (GGF) was founded. It assumed the role of an OLR and allowed the central bank to concentrate on the LLR function. The aim was to ensure the stability of the banking system and to secure claims of domestic and foreign depositors. In contrast to the Swedish BSA, funds available for GGF were limited and increases in the allocation of funds had to be approved by the Finnish Parliament. The GGF could support financial institutions directly by issuing guarantees or by injecting capital into banks or indirectly through the already existing security funds of the various banking groups. However, distortionary effects on competition had to be avoided (Nyberg & Vihriälä (1994)).

At the beginning of 1992, the GGF offered equity capital (preferred capital certificates) to all deposit banks, regardless of their solvency, but in relation to their risk-weighted assets. For

¹⁶Later, these banks as well as "Merita Bank", "Unidanmark" and "Christiania Bank" formed the "Nordea banking group", the largest in Scandinavia (Englund & Vihriälä (2009)).

the first three years, banks had to pay interest on these certificates slightly above the market rate. Thereafter, the differential increased. The government had the right to convert these certificates into ordinary shares once the bank failed to fulfil its interest payments or the its equity ratio fell below a required threshold. Almost all banks made use of this offer (Nyberg & Vihriälä (1994)).

Furthermore, the GGF supported a merger of 41 distressed banks which formed the "Savings Bank of Finland" (SBF) and which received several capital injections until 1996 (Englund & Vihriälä (2009); Nyberg & Vihriälä (1994)). The merger and a stringent restructuring programme were the preconditions for the support by the GGF. This was adjudged to be the unique solution, as several savings banks had come into financial distress because of their common responsibility for each other's solvency and due to the fact that shares in Skopbank comprised a large part of their assets (Nyberg & Vihriälä (1994)). The government intervened further into the banking sector when in 1992 it took over a large part of the "toxic assets" of a small commercial bank ("STS-Bank") which had been acquired by one of the largest banks "Kansallis-Osake-Pankki" (KOP).

In early 1993, the government announced a blanket guarantee for all liabilities of Finnish deposit banks and in mid 1993 the GGF guaranteed for the Tier-2-capital as well as for interest payments of the two major commercial banks, "KOP" and "Suomen Yhdyspankki" (SYP) (Englund & Vihriälä (2009)). However, only bank creditors and not bank equity holders were protected (Sandal (2004)). In addition, non-performing or defaulting loans from several banks, e.g. "Skopbank", "STS-Bank" and "SBF", were transferred to a newly established state-owned bank ("Asset Management Corporation Arsenal"; Englund & Vihriälä (2009); Nyberg & Vihriälä (1994)).

Similar to the developments in Sweden, the depreciation of the Finnish currency and the reduction of interest rates in 1993 and 1994 supported the export market and increased share prices. The banking sector improved in both of these years as well as in the years that followed, though the non-performing loans were still responsible for the non-profitability in 1993, despite the decrease of interest rates. The situation remained critical, especially in the case of "SBF" and "Skopbank" (Nyberg & Vihriälä (1994); Drees & Pazarbasioglu (1995)). However, the reduction of the number of assets through several mergers increased the efficiency of the Finnish banking sector and contributed to the return of profitability in the banking sector in the mid 1990s. "STS-Bank" was merged with "KOP", which itself became part of the merger with "SYP" in 1995. The new bank, "Merita Bank", became part of the "Nordea Bank". The performing parts of the "SBF" were merged with other commercial bank cooperative banks as well as the state-owned Post-Office-Bank (Honkapohja (2009)).¹⁷

¹⁷The appendix provides an overview of similarities and differences in crisis resolution between Japan, Norway, Sweden and Finland.

6.3.3 Determinants of crisis resolution paths

As mentioned above, political preferences as well as coordination failures may shape a country's crisis resolution package. Political preferences were important in all four countries, but their effects on the crisis resolution differed in each country. In Japan public opinion initially heavily opposed injections of tax payers' money into ailing banks. This became "almost a political taboo" (Nakaso (2001)). Such opposition was much weaker in the Nordic countries, especially in Norway and Sweden, due to a long history of partnership between the public sector and the private sector (Sandal (2004); Englund & Vihriälä (2009); Jonung (2009); Eckbo (2010)).

Although authorities in the Nordic countries were less reluctant to provide public funds to the ailing banks, they initially shared with Japan the focus on private sector solution. These attempts to support private mergers and acquisitions may have resulted from the fact that the authorities tried to avoid moral hazard among banks, as private solutions tend to have a stabilizing effect (Perotti & Suarez (2002); Acharya & Yorulmazer (2007); Acharya & Yorulmazer (2008)). However, private sector solutions became infeasible, either because the amounts needed were too large or because the acquiring banks did not participate. They feared getting into difficulties themselves.

Once private sector solutions became impossible, two types of public interventions remained: liquidation or provision of financial support to ailing banks. Authorities in all four countries chose the latter possibility and provided liquidity as well as solvency assistance. Liquidity support was provided to individual banks and to the market in all four countries. While the BoJ immediately provided liquidity to the market at low interest rates, the CBs in the Nordic countries were not able to change their domestic interest rates before de-pegging their currencies. Whether the decrease of interest rates by the BoJ was an advantage over the CBs in the Nordic countries remains doubtful because lower interest rates may support the recovery process, but may also encourage the risk-taking incentives of banks. Due to the peg of the currencies, the commitment not to lower interest rates and to bail banks out may have been more credible in the Nordic countries than in Japan and may have prevented banks from gambling (Farhi & Tirole (2009)). In Japan such a commitment was not feasible.

Apart from liquidity assistance, banks in all four countries received solvency assistance. This way, authorities accepted moral hazard among creditors because the social costs of systemic crisis were regarded as being larger than the costs of additional risk-taking by the banks. As a consequence, bank resolutions under ordinary insolvency laws were not applied to prevent systemic effects, despite the fact that this may have created the least moral hazard, at least in case of low solvency shocks (because senior management would lose their jobs, shareholders would lose their equity holdings and creditors including depositors would be subject to a haircut). Rather, an approach outside the legal framework of existing insolvency laws was applied which fully protected creditors. To reduce moral hazard on the side of bank management and shareholders, the senior management in all four countries was often replaced and shareholders' capital was used to cover bank losses, but additional public funds were injected into ailing

banks in order to prevent a haircut on creditors' claims. Thus, moral hazard was contained only on the sides of management and shareholders, but not on the side of creditors who were not required to take responsibility for bank failure (Nakaso (2001); Sandal (2004)).

Political preferences shaped the way ailing banks were targeted. Authorities in all four countries provided solvency assistance through the liability side of the banks' balance sheets and injected capital into banks, mostly in the form of preferred shares and subordinated debt. While the impact of recapitalizations on risk-taking is ambiguous, they allow for participating preferences in upside gains. Yet, authorities had to recapitalize not only insolvent banks, but also solvent institutions, as became obvious from the aborted attempt to recapitalize insolvent Japanese banks in February 1998. It failed because banks with financial difficulties hesitated to apply for financial assistance in order not to be singled out as a bank with financial difficulties. Instead, they tried to hide their non-performing loans (NPLs) on their balance sheet from supervisors (Hoshi & Kashyap (2010)). Japanese banks had little incentives to remove NPLs from their balance sheets because the opportunity costs of holding them were low, due to the loose monetary policy of the Bank of Japan and to extremely low interest rates (Nakaso (2001)). To prevent such negative incentive effects, regulators had to offer financial assistance across the board, which made crisis resolution more costly for tax payers, especially in Japan, where the number of banks was large.

In addition to recapitalizations, authorities in Japan, Sweden and Finland initially also used a bad bank scheme, but rather in a piecemeal fashion. This was due to the fact that the transfer of assets from an ailing bank to another institution was connected with several legal and economic problems, such as the setting of transfer prices and the withdrawal of experts from the distressed banks (Vale (2004)). Sweden, Finland and Japan also announced a blanket guarantee for bank creditors (Sandal (2004); Jonung (2009)). However, as mentioned above, the impact of equity injections and bank guarantees is not clear-cut (Hakenes & Schnabel (2010)).

Apart from political preferences, it were also transaction costs, misallocations of political responsibilities and coordination failures within the political sectors which shaped the course of banking crisis resolution paths, especially in Japan. After the breakout of the crisis, the Bank of Japan had to act not only as an LLR, but also as an OLR. This was due to the fact that a public recapitalization fund was not available and the "payoff cost limit" prohibited the Japanese Deposit Insurance Company (DIC) to provide liquidity assistance to ailing banks. This contrasted with Norway and Sweden where public funds were quickly established and allowed authorities to recapitalize ailing banks without taking recourse to the CBs.

In Japan, it took several years to implement major legislative reforms to remove the payoff cost limit (in 1996) and to permit recapitalizations of nationalized banks (in 1998). In the meantime, the Bank of Japan was forced to take considerable risks on their balance sheets and even, as in case of the bailout of "Nippon Credit Bank", to incur painful capital losses. Such losses helped to protect bank creditors and to prevent systemic effects, but at the same time undermined public confidence in the BoJ and in the stability of the financial system. The Bank

of Japan was heavily criticized on these grounds in the Japanese public and in the National Parliament (Nakaso (2001)).

Suboptimal allocations of responsibilities between regulatory authorities further aggravated the crisis in Japan when the two securities houses “Sanyo” and “Yamaichi” ailed in autumn 1997. Although security houses acted as participants in the interbank markets, their liabilities to counterparties were not covered by the Deposit Insurance Corporation. The BoJ refused to provide liquidity support to “Sanyo” because it was legally impossible to use the deposit insurance fund to co-insure the BoJ against potential credit losses. The BoJ tried to negotiate an agreement with the MoF on this matter, but this needed approval from the National Parliament. Such an agreement was reached only very shortly before the possible failure of “Yamaichi Securities”, which eventually received liquidity support from the BoJ (Nakaso (2001)).

The resolution packages in Japan and the Nordic countries caused different fiscal and social costs. For Japan, gross fiscal costs are estimated between 14 % and more than 20 % of GDP and output losses amounted to 45 % of GDP. Public debt increased by 41.7 % of GDP. For Finland, gross fiscal costs are estimated between 8.9 % or 12.8 % of GDP. Output loss reached 69.6 % of GDP. Public debt increased by 43.6 % of GDP. These numbers are much higher than for Norway and Sweden. For Norway, gross fiscal costs are estimated between 2.0 % and 8.0 % of GDP. Estimated output losses reach 5.1 % of GDP and public debt increased by 19.2 %. For Sweden, gross fiscal costs amounted between 3.6 % and 4.0 % of GDP and output losses reached 32.9 % of GDP. Public debt increased by 36.2 % of GDP (all numbers are from Sandal (2004); Laeven & Valencia (2012); Honohan & Klingebiel (2003)).

6.4 Reassessment of current crisis resolution procedures

Although the crises in Japan and in the Nordic countries were rather local events and took place in less complex financial systems, they share some important similarities to the recent financial turmoil.¹⁸ Before the start of the current crisis, financial institutions across the board in the US were heavily exposed to the real estate sector, and real estate price indices declined significantly. Provisioning by banks was insufficient and informational asymmetries about a single bank's solvency caused a breakdown of interbank lending and a significant rise in interest rates for unsecured interbank loans. Regulators initially accepted failures of some non-deposit taking institutions, such as Lehman Brothers in the US or Northern Rock in the UK, but underestimated the consequences for risk sensitivity of lender on interbank markets. Similar to their predecessors during the 1990s, they avoided haircuts for creditors

¹⁸This applies at least to the US and to the subprime crisis in Europe. With respect to the European sovereign debt crisis since 2010, Europe differs from Japan, which did not suffer yet from a sovereign debt crisis.

due to fear of contagion and systemic crises. As deposit insurance corporations were not funded, the initial burden of adjustment was mainly with the central banks which acted as LLR and took considerable risks on their balance sheets. Similar to the Nordic countries and Japan, the authorities in the recent crisis used asset purchase programmes, issued guarantees to a large extent and partially transferred assets to bad banks (Laeven & Valencia (2010); Laeven & Valencia (2012); Claessens, Pazarbasioglu, Laeven, Dobler, Valencia, Nedelescu & Seal (2011)).

Despite these similarities, there are some important differences in crisis reaction, especially with respect to the Japanese case. Firstly, authorities both in the US and in Europe were more willing to inject risk capital into ailing banks than Japanese authorities during the 1990s. While political opposition against bank bail-outs was considerable in Japan, the US government already started in October 2008 the “Troubled Assets Relief Program (TARP)” and the “Capital Purchase Program (CPP)” which allowed the US Ministry of Finance to purchase troubled assets from financial institutions or to provide them with capital. In Europe, in September 2008, the German government founded the “Special Financial Market Stabilization Funds” (Sonderfonds Finanzmarktstabilisierung, SoFFin; since 2011: “Finanzmarktstabilisierungsanstalt”), which was empowered to provide liquidity to eligible financial institutions (mainly by guaranteeing debt issues) or to recapitalize ailing banks (such as “Commerzbank AG” or “Hypo Real Estate Holding AG”). Similar programmes were also introduced in other European countries, such as in France (“Société de prise de participations de l’Etat (SPPE)”), in Italy (“Ministry of Economy and Finance”) or in the UK (“Government Recapitalization Scheme”; Faeh, Grande, Ho, King, Levy, Panetta, Signoretti, Taboga & Zaghini (2009); Petrovic & Tutsch (2009)).

Secondly, authorities in the US and in Europe quickly started implementing special bank resolution schemes into national legislation (see Deutsche Bundesbank (2011); Cihak & Nier (2012)). Such schemes allow authorities an orderly wind-down of systemically important financial institutions (SIFIs). Ordinary bankruptcy codes are usually insufficient to reach that goal because they usually stipulate a suspension of all payments after failure has been declared. This provision intends to treat all creditors equally. Such a suspension of payments, however, could cause considerable damage in the case of failure of a financial institution which acts as a clearing house for many counterparties. To prevent this damage, special bank resolution schemes usually ensure that SIFIs continue their ordinary payment services (Fukao (2000)).

Thirdly, central banks intervened on a more massive and widespread scale than in the past, at least with respect to liquidity support for interbank markets and particular institutions. While during the 1990s interest rates in the Nordic countries and in Japan were kept at a high level or even increased in order to avoid a depreciation of their currencies, interest rates in the US and Europe were quickly decreased to a low level (Claessens et al. (2011)). In contrast to Japan and Finland, the central banks did not inject risk capital in the course of the recent crisis, but only provided liquidity support to financial institutions.

Finally, the recent financial crisis differed in the economic and fiscal costs from the crises in Japan and the Nordic countries. Laeven & Valencia (2012) determine gross fiscal costs of

3.9% of GDP in the Euro area and 4.5% of GDP in the United States. Taking the advanced economies into account, Laeven & Valencia (2010) calculate direct fiscal costs of 5.9% for the years 2007-2009. In comparison with the Nordic countries and Japan, the fiscal costs in the recent financial crisis were rather low. Output losses amounted to 23% of GDP in the Euro area and 31% of GDP in the US, which is higher than output losses in Norway and similar to output losses in Sweden, but lower than output losses in Japan and Finland. In the recent crisis the public debt increased by 19.9% of GDP in the Euro area and by 23.6% in the US. Both figures are similar to the increase in public debt in Norway, but much lower than the increase in debt in Sweden, Finland and Japan during the 1990s (Laeven & Valencia (2012)).

Despite these numbers, current crisis resolution packages still suffered from major drawbacks which made appropriate reactions difficult. One major drawback was the inability of authorities to handle systemically important financial institutions (SIFIs) which are considered as being too complex to be resolved in a short period of time. In reaction, legislators became entitled to demand SIFIs to write “living wills” which describe in advance how an ailing bank could be quickly resolved (Avgoulaeas, Goodhart & Schoenmaker (2012); Huertas (2012)). In contrast to bankruptcy procedures for normal industrial companies, where a liquidator often commands creditor protection, it is impossible for a banking company to execute such a suspension of payments because it could mean illiquidity for other financial or non-financial companies. Therefore bankruptcy procedures for banks have to be executed very quickly and the ailing bank has to maintain vital payments to other banks. Living wills help to distinguish vital from non-vital payments and thus help to remove pressures from regulators to bail-out an ailing bank because they do not know what services are vital for the functioning of the banking system.

6.5 Conclusion

The purpose of this chapter was to find out which difficulties authorities face when they have to solve a banking crisis. Our survey of the theoretical and empirical banking literature has shown that there is no “best-practice” banking crisis resolution package which dominates all others in terms of social and fiscal costs and effects of risk-taking. Instead, authorities face important trade-offs, because instruments with only small adverse incentives for banks’ risk-taking are often costly to implement. Moreover, even the impact of single resolution instruments on moral hazard is often not clear-cut. Since no superior policy package exists, policy reactions are country-specific and depend on policy makers’ preferences. The implementation of a preferred crisis resolution package, however, is often subject to coordination failures within the political sector, which create additional costs for society. These coordination failures result from suboptimal allocations of regulatory responsibilities between single authorities and from commitment problems which force regulators to choose an inferior crisis resolution package.

Our case study has shown that policy makers in all countries considered here avoided haircuts for creditors and thus allowed for some additional moral hazard, because they feared

the social costs of a systemic financial crisis. While this package made some form of bank recapitalization necessary, authorities in Japan lacked public support and the necessary legal instruments to provide solvency assistance to ailing banks. In addition, badly-defined political responsibilities for bank crisis resolution and commitment problems made the implementation of the chosen resolution package difficult and costly in terms of fiscal outlays and output loss. This contrasted with two of the Nordic countries, where political resentments against public bailouts were less significant, banks were quickly recapitalized and coordination failures were less relevant. The resolution of the recent financial crisis revealed some similarities, but also differences to the crises in Japan and the Nordic countries in the 1990s. At the beginning, one attempted to solve the crisis by private solutions and to avoid moral hazard by liquidating ailing institutions. However, when this approach failed, authorities massively injected capital into insolvent banks and provided guarantees. Moreover, measures were often taken ad hoc.

Although many lessons learnt were incorporated into the new regulatory framework - such as a list of available resolution tools, which lowers transaction costs - further efforts are necessary to resolve future crises efficiently. Firstly, coordination failures may still exist. In the Eurozone, for instance, the European Central Bank's policy is not restricted to liquidity provision. As we have seen in Japan and Finland, a clear cut between liquidity provision and solvency assistance may be more appropriate. Otherwise, if the central bank injects equity into ailing banks, its incentives may change and therefore, evoke commitment problems. Secondly, political processes of long duration should be avoided. If the political parties have to become aware of their preferences within a crisis, the decision-making process may last too long, which may aggravate the crisis situation. Therefore, political parties should be aware of their preferences ex ante. Thirdly, each resolution authority should develop a list of potential obstacles for efficient resolutions and try to eliminate them in advance. Finally, further research is necessary in order to have a clear picture of how single resolution instruments affect fiscal costs and moral hazard.

Appendix

Table 6.2: Important crisis resolution measures in Norway, Sweden, Finland and Japan

| Norway | Sweden | Finland | Japan |
|--|---|---|--|
| 1988 | | | |
| Guarantee (CBGF) (all claims) for a regional commercial bank Liquidity support and subsidized loan (CB) 2 regional savings | | | |
| 1989 | | | |
| Small commercial bank set under public administration | | | |
| 1990 | | | |
| Equity guarantee (CBGF) for Fokus Bank | | | |
| 1991 | | | |
| Preference capital (GBIF/CBGF) for Christiania Bank and Fokus Bank Primary capital certificates (GBIF/SBGF) for 2 savings banks Preference capital (GBIF) Den norske Share capital (GBIF) for Fokus Bank and Christiania Bank | Equity (government) for Nordbanken Loan guarantee (government) for Första Sparbanken | Take-over of Skopbank by Bank of Finland | Resolution of Toho Sogo Bank announced |
| 1992 | | | |
| Preferred capital (GBIF) for Den norske Bank | Loan provision and loan guarantee (gov) for Första Sparebanken (guarantee transformed into subsidized loan) | Preferred capital certificates (convertible into voting shares) for deposit banks (accepted by all banks) | |

| | | | |
|---|--|---|---|
| Preferred capital and subordinated loan (GBIF) for Christiania Bank | Nationalization of Nordbanken which is split into "Good" and "Bad" bank (Securum) | GGF acquires Skopbank from Bank of Finland and injects preferred capital certificates and share capital | |
| Share capital (GBIF) for Fokus Bank | Equity capital injection (gov) for Nordbanken and Securum | Half of the savings banks are merged into Savings Bank of Finland | |
| Primary capital certificates (GBIF and SBGF) for 4 regional banks | Government assumes all commitments of Gota Group and transfers non-performing loans to Securum Parent company of Gota Group declared bankrupt | GGF provides subordinated loans, preferred capital certificates and share capital for Savings Bank of Finland | |
| 1993 | | | |
| | Bank Support Agency provides a convertible guarantee for Föreningsbanken | STS transferred into bad bank and performing assets sold to KOP GGF provides preferred capital certificates for Skopbank, STS-Bank and the Savings Bank of Finland GGF injects share capital into Savings Bank of Finland | |
| 1994 | | | |
| | | | Announcement of the resolution of Tokyo Kyowa and Anzen |
| 1995 | | | |

| | | | |
|--|--|--|---|
| GBIF sells its shares of Fokus Bank and Christiania Bank (GBF remained shareholder of Christiania Bank until 2000 and is still shareholder of Den norske Bank) | | | <p>Establishment of TKB (capital injection by private investors and BoJ)</p> <p>Cosmo Credit Cooperative (business transferred to TKB in 1996) and Kizu Credit Cooperative suspend operations</p> <p>Announcement of the resolution of Hyogo Bank (business transferred to Midori Bank in 1996)</p> |
| 1996 | | | |
| | | | <p>Announcement of the resolution of Taiheiyou Bank</p> <p>Hanwa Bank ordered to suspend operations</p> <p>Tokyo Kyodou Bank reorganized into Resolution and Collection Bank</p> |
| 1997 | | | |
| | | | <p>Announcement of the resolution of Kyoto Kyoei Bank, Hokkaido Takushoku Bank and Tokyo City Bank</p> <p>BoJ declares all deposits to be secured</p> |
| 1998 | | | |

| | | | |
|------|--|--|--|
| | | | <p>Issuance of preferred capital and subordinated loans to 21 banks</p> <p>LTC and NCB placed under Special Public Administration (nationalized)</p> |
| 1999 | | | |
| | | | <p>Kokumin Bank, Koufuku Bank, Tokyo Sowa Bank, Namihaya Bank and Niigate Chuo Bank placed under management of FRA (liquidity support by BoJ and bad loans transferred to the RCC)</p> <p>Issuance of preferred shares and subordinated debt until 2002 (32 banks)</p> |
| 2003 | | | |
| | | | <p>Issuance of subordinated debt (1 bank) and issuance of common and preferred shares (1 bank)</p> |
| 2006 | | | |
| | | | <p>Issuance of preferred shares until 2009 (5 banks)</p> |

Chapter 7

Conclusion

The aim of this dissertation was to analyse the effects of selected intervention measures during financial crises on the risk-taking behaviour of banks. In the theoretical part, we focused on the impact of bank bailouts and a bank levy on banks' risk behaviour. An overview of potential regulatory instruments and their impact on bank behaviour was provided in the chapter, where a case-study was presented.

A main result is that the relation between bank bailouts and risk behaviour depends on the banks' macroeconomic environment, the regulator's ability to evaluate how the bank in distress is affected by the macroeconomic situation and on the interconnectedness of banks. These factors should be taken into account when empirical studies are launched. A best practice policy, however, is still a major task in economic research. The literature still does not provide clear predictions about the effects of rescue measures.

An adequate allocation of responsibilities plays a key role, not only in the success of banking crisis resolution, but also in the relationship between bailouts and risk-taking. The financial crises in Japan and the Nordic countries in the 1990s have shown that the absence of institutions whose key responsibility is to intervene in case of emergency may extend the crisis and raise costs. Since regulators have their own incentives when deciding about whether to rescue or liquidate, it can be a difficult task to allocate these responsibilities properly. In the European Monetary Union, the regulation for bank recovery and resolution has recently been adopted. However, agreements about burden sharing have not been signed yet, at least, on a global level. As long as this challenge has not been accepted and solved, the supervisory framework will be fragile. Since host, home and multinational authorities have different incentives to rescue or/and to liquidate financial institutions, it remains unclear who rescues or liquidates when. This ambiguity can be beneficial from a risk point of view in some circumstances, but the avoidance of moral hazard is not the unique aim of a prudent regulation.

Fiscal costs and output losses are important factors, too. Whether such an ambiguity saves costs remains doubtful. The cost issue also plays its role when deciding about the proper bailout instruments. Especially small countries might be unable to bear the whole

fiscal costs of rescue measures. The determination of how costly selected instruments are and how effective they are with regard to a solution of the crisis and to the prevention of distortive incentives among banks then becomes an even more important and urgent task, especially if assistance from other countries or international institutions is required.

Bibliography

- Acemoglu, D. (2003). Why not a political coase theorem? Social conflict, commitment, and politics, *Journal of Comparative Economics* **31**(4): 620–652.
- Acharya, V. (2003). Is the international convergence of capital adequacy regulation desirable?, *The Journal of Finance* **58**(6): 2745–2782.
- Acharya, V., Gromb, D. & Yorulmazer, T. (2012). Imperfect competition in the interbank market for liquidity as a rationale for central banking, *American Economic Journal: Macroeconomics* **4**(2): 184–217.
- Acharya, V. & Richardson, M. (2009). Causes of the financial crisis, *Critical Review* **21**(2-3): 195–210.
- Acharya, V., Shin, H. & Yorulmazer, T. (2011). Crisis resolution and bank liquidity, *The Review of Financial Studies* **24**(6): 2166–2205.
- Acharya, V. & Skeie, D. (2011). A model of liquidity hoarding and term premia in inter-bank markets, *Journal of Monetary Economics* **58**(5): 436–447.
- Acharya, V. V., Drechsler, I. & Schnabl, P. (2011). A pyrrhic victory? - Bank bailouts and sovereign credit risk, *NBER Working Paper No. 17136*. National Bureau of Economic Research, Cambridge, Massachusetts.
- Acharya, V. V., Pedersen, L., Philippon, T. & Richardson, M. (2013). Taxing systemic risk, in J.-P. Fouque & J. A. Langsam (eds), *Handbook on systemic risk*, Cambridge, pp. 226–246.
- Acharya, V. & Yorulmazer, T. (2007). Too many to fail - An analysis of time-inconsistency in bank closure policies, *Journal of Financial Intermediation* **16**(1): 1–31.
- Acharya, V. & Yorulmazer, T. (2008). Cash-in-the-market pricing and optimal resolution of bank failures, *The Review of Financial Studies* **21**(6): 2705–2742.
- Albertazzi, U. & Gambacorta, L. (2010). Bank profitability and taxation, *Journal of Banking & Finance* **34**(11): 2801–2810.

- Allen, F., Babus, A. & Carletti, E. (2009). Financial crises: Theory and evidence, *Annual Review of Financial Economics* **1**(1): 97–116.
- Allen, F., Beck, T., Carletti, E., Lane, P., Schoenmaker, D. & Wagner, W. (2011). *Cross-border banking in Europe: Implications for financial stability and macroeconomic policies*. Centre for Economic Policy Research, London.
- Allen, F. & Carletti, E. (2010). An overview of the crisis: Causes, consequences, and solutions, *International Review of Finance* **10**(1): 1–26.
- Allen, F. & Gale, D. (1999). Bubbles, crises, and policy, *Oxford Review of Economic Policy* **15**(3): 9–18.
- Allen, F. & Gale, D. (2000). Financial contagion, *Journal of Political Economy* **108**(1): 1–33.
- Altunbas, Y., Gambacorta, L. & Marqués-Ibáñez, D. (2010). Does monetary policy affect bank risk-taking?, *ECB Working Paper No. 1166*. European Central Bank, Frankfurt am Main.
- Avery, R., Belton, T. & Goldberg, M. (1988). Market discipline in regulating bank risk: New evidence from the capital markets, *Journal of Money, Credit and Banking* **20**(4): 597–610.
- Bagehot, W. (1873). *Lombard Street: A description of the Money Market*, London.
- Basel Committee on Banking Supervision (2010). Report and recommendations of the cross-border bank resolution group. Bank for International Settlements, Basel.
- Bebenroth, R., Dietrich, D. & Vollmer, U. (2009). Bank regulation and supervision in bank-dominated financial systems: A comparison between Japan and Germany, *European Journal of Law and Economics* **27**(2): 177–209.
- Beck, T. (2011). The future of banking - solving the current crisis while addressing long-term challenges, in T. Beck (ed.), *The Future of Banking*, Centre for Economic Policy Research, London, pp. 1–8.
- Beck, T., Coyle, D., Dewatripont, M., Freixas, X. & Seabright, P. (2010). *Bailing out the banks: Reconciling stability and competition*. Centre for Economic and Policy Research, London.
- Beck, T., Demirgüç-Kunt, A. & Levine, R. (2006). Bank concentration, competition, and crises: First results, *Journal of Banking & Finance* **30**(5): 1581–1603.
- Beck, T., Todorov, R. & Wagner, W. (2011). Bank supervision going global? A cost-benefit analysis, *Working Paper*. University of Tilburg.

- Berger, A., Bouwman, C., Kick, T. & Schaeck, K. (2012). Bank risk taking and liquidity creation following regulatory interventions and capital support, *Working Paper*. South Carolina, Cleveland, Frankfurt am Main, and Bangor.
- Berger, A. N., Klapper, L. F. & Turk-Ariss, R. (2009). Bank competition and financial stability, *Journal of Financial Services Research* **35**(2): 99–118.
- Bester, H. (1985). Screening vs. rationing in credit markets with imperfect information, *The American Economic Review* **75**(4): 850–855.
- Bhattacharya, S. & Gale, D. M. (2011). Preference shocks, liquidity, and central bank policy, in F. Allen, E. Carletti, J. P. Krahnen & M. Tyrell (eds), *Liquidity and Crises*, Oxford, pp. 35–50.
- Black, L. & Hazelwood, L. (2013). The effect of TARP on bank risk-taking, *Journal of Financial Stability* **9**(4): 790–803.
- Bolt, W. & Tieman, A. F. (2004). Bank competition, risk and regulation, *The Scandinavian Journal of Economics* **106**(4): 783–804.
- Bordo, M. (2008). An historical perspective on the crisis of 2007-2008, *Working Paper No. 14569*. National Bureau of Economic Research, Cambridge, Massachusetts.
- Boyd, J. H. & De Nicoló, G. (2005). The theory of bank risk taking and competition revisited, *The Journal of Finance* **60**(3): 1329–1343.
- Buch, C. M., Hilberg, B. & Tonzer, L. (2013). Taxing banks: An evaluation of the German bank levy, *Working Paper*. Halle, Frankfurt am Main, Florenz.
- Bulow, J. & Klemperer, P. (2009). Reorganising the banks: Focus on the liabilities, not the assets, *VoxEU*. Centre for Economic Policy Research, London.
- Caballero, R. J., Hoshi, T. & Kashyap, A. K. (2008). Zombie lending and depressed restructuring in Japan, *The American Economic Review* **98**(5): 1943–1977.
- Calem, P. & Rob, R. (1999). The impact of capital-based regulation on bank risk-taking, *Journal of Financial Intermediation* **8**(4): 317–352.
- Calomiris, C., Klingebiel, D. & Laeven, L. (2004). A taxonomy of financial crisis resolution mechanisms: Cross-country experience, *World Bank Policy Research Working Paper No. 3379*. Washington, D.C.
- Calzolari, G. & Loranth, G. (2011). Regulation of multinational banks: A theoretical inquiry, *Journal of Financial Intermediation* **20**(2): 178–198.

- Caprio, G. & Klingebiel, D. (2002). Episodes of systemic and borderline banking crises, in D. Klingebiel & L. Laeven (eds), *Managing the Real and Fiscal Effects of Banking Crises*, Wordbank, Washington, D.C, pp. 31–49.
- Carletti, E. (2008). Competition and regulation in banking, in A. W. A. Boot & A. V. Thakor (eds), *Handbook of Financial Intermediation and Banking*, San Diego, pp. 449–482.
- Castiglionesi, F. & Wagner, W. (2012). Turning Bagehot on his head: Lending at penalty rates when banks can become insolvent, *Journal of Money, Credit and Banking* 44(1): 201–219.
- Chan, Y.-S., Greenbaum, S. I. & Thakor, A. V. (1992). Is fairly priced deposit insurance possible?, *The Journal of Finance* 47(1): 227–245.
- Claessens, S., Pazarbasioglu, C., Laeven, L., Dobler, M., Valencia, F., Nedelescu, O. & Seal, K. (2011). Crisis management and resolution: Early lessons from the financial crisis, *IMF Staff Discussion Note No. 11/05*. International Monetary Fund, Washington, D.C.
- Cordella, T. & Yeyati, E. L. (2002). Financial opening, deposit insurance and risk in a model of banking competition, *European Economic Review* 46(3): 471–485.
- Cordella, T. & Yeyati, E. L. (2003). Bank bailouts: Moral hazard vs. value effect, *Journal of Financial Intermediation* 12(4): 300–330.
- Cukierman, A. (2011). Reflections on the crisis and on its lessons for regulatory reform and for central bank policies, *Journal of Financial Stability* 7(1): 26–37.
- Dam, L. & Koetter, M. (2012). Bank bailouts and moral hazard: Evidence from Germany, *The Review of Financial Studies* 25(8): 2343–2380.
- De Nicolò, G., Dell’Ariccia, G., Laeven, L. & Valencia, F. (2010). Monetary policy and bank risk taking, *IMF Staff Position Note No. 10/09*. International Monetary Fund, Washington, D.C.
- De Nicoló, G. & Lucchetta, M. (2011). Bank competition and financial stability: A general equilibrium exposition, *IMF Working Paper No. 11/295*. International Monetary Fund, Washington, D.C.
- Dell’Ariccia, G. & Marquez, R. (2006). Competition among regulators and credit market integration, *Journal of Financial Economics* 79(2): 401–430.
- Dell’Ariccia, G. & Ratnovski, L. (2011). Bailouts, contagion and risk-taking, *Working Paper*. International Monetary Fund, Washington D.C.
- Demirgüç-Kunt, A. & Huizinga, H. (1999). Determinants of commercial bank interest margins and profitability: Some international evidence, *The World Bank Economic Review* 13(2): 379–408.

- Demirgüç-Kunt, A. & Huizinga, H. (2001). The taxation of domestic and foreign banking, *Journal of Public Economics* **79**(3): 429–453.
- Deutsche Bundesbank (2011). Fundamental features of the German bank restructuring act, *Monthly Bulletin* **63**(6): 59–75.
- Dewatripont, M. & Freixas, X. (2011). Bank resolution: A framework for the assessment of regulatory intervention, *Oxford Review of Economic Policy* **27**(3): 411–436.
- Dewatripont, M., Rochet, J.-C. & Tirole, J. (2010). *Balancing the banks: Global Lessons from the Financial Crisis*, Princeton.
- DeYoung, R., Kowalik, M. & Reidhill, J. (2013). A theory of failed bank resolution: Technological change and political economics, *Journal of Financial Stability* **9**(4): 612–627.
- Dietrich, D. & Hauck, A. (2012). Government interventions in banking crises: Effects of alternative schemes on bank lending and risk taking, *Scottish Journal of Political Economy* **59**(2): 133–161.
- Dietrich, D. & Vollmer, U. (2010). International banking and liquidity allocation, *Journal of Financial Services Research* **37**(1): 45–69.
- Drees, B. & Pazarbasioglu, C. (1995). The Nordic banking crises: Pitfalls in financial liberalization, *IMF Working Paper 95/61*. International Monetary Fund, Washington, D.C.
- Duchin, R. & Sosyura, D. (2013). Safer ratios, riskier portfolios: Banks' response to government aid, *Ross School of Business Working Paper No. 1165*. Michigan.
- Eckbo, B. E. (2010). Banking system bailout - Scandinavian style, *Journal of Applied Corporate Finance* **22**(3): 85–93.
- Eisenschmidt, J. & Tapking, J. (2009). Liquidity risk premia in unsecured interbank money markets, *ECB Working Paper No. 1025*. European Central Bank, Frankfurt am Main.
- Englund, P. (1999). The Swedish banking crisis: Roots and consequences, *Oxford Review of Economic Policy* **15**(3): 80–97.
- Englund, P. & Vihriälä, V. (2009). Financial crisis in Finland and Sweden: Similar but not quite the same, in L. Jonung, J. Kiander & P. Vartia (eds), *The Great Financial Crisis in Finland and Sweden*, Cheltenham, UK, pp. 71–130.
- Espinosa-Vega, M., Kahn, C., Sole, J. & Matta, R. (2011). Systemic risk and optimal regulatory architecture, *IMF Working Paper 11/193*. International Monetary Fund, Washington, D.C.
- European Central Bank (2010). The ECB's response to the financial crisis, *Monthly Bulletin* **10/2010**.

- European Commission (2010). Innovative financing at a global level, *SEC (2010) 409 (October)* . Brussels: European Commission.
- Faeh, T., Grande, G., Ho, C., King, M. R., Levy, A., Panetta, F., Signoretti, F. M., Taboga, M. & Zaghini, A. (2009). An assessment of financial sector rescue programmes, *Bank of Italy Occasional Paper No. 47* . Rome.
- Fama, E. F. (1985). What's different about banks?, *Journal of Monetary Economics* **15**(1): 29–39.
- Farhi, E. & Tirole, J. (2009). Leverage and the central banker's put, *The American Economic Review* **99**(2): 589–593.
- Farhi, E. & Tirole, J. (2012). Collective moral hazard, maturity mismatch, and systemic bailouts, *The American Economic Review* **102**(1): 60–93.
- Financial Stability Board (2010). Reducing the moral hazard posed by systemically important financial institutions - FSB recommendations and time lines. Basel.
- Flannery, M. & Sorescu, S. (1996). Evidence of bank market discipline in subordinated debenture yields: 1983–1991, *The Journal of Finance* **51**(4): 1347–1377.
- Freixas, X. (1999). Optimal bail out policy, conditionality and constructive ambiguity, *Working Paper* . Universitat Pompeu Fabra, Barcelona.
- Freixas, X. (2010). Post-crisis challenges to bank regulation, *Economic Policy* **25**(62): 375–399.
- Freixas, X., Giannini, C., Hoggarth, G. & Soussa, F. (2000). Lender of last resort: What have we learned since Bagehot?, *Journal of Financial Services Research* **18**(1): 63–84.
- Freixas, X., Parigi, B. & Rochet, J. (2000). Systemic risk, interbank relations, and liquidity provision by the central bank, *Journal of Money, Credit and Banking* **32**(3): 611–638.
- Freixas, X. & Rochet, J.-C. (2008). *Microeconomics of Banking*, Cambridge, Massachusetts.
- Fudenberg, D. & Tirole, J. (1995). *Game Theory*, Cambridge, Massachusetts.
- Fujii, M. & Kawai, M. (2010). Lessons from Japan's banking crisis, 1991-2005, *ADB Working Paper No. 222* . Asian Development Bank Institute, Tokyo.
- Fukao, M. (2000). Recapitalizing Japan's banks: The functions and problems of financial revitalization act and bank recapitalization act, *Keio Business Review* **38**: 1–16.
- Fukao, M. (2003). Japan's lost decade and its financial system, *The World Economy* **26**(3): 365–384.

- Gale, D. (2010). Capital regulation and risk sharing, *International Journal of Central Banking* 6(34): 187–204.
- Giannetti, M. (2003). Bank-firm relationships and contagious banking crises, *Journal of Money, Credit and Banking* 35(2): 239–261.
- Gilson, S., John, K. & Lang, L. (1990). Troubled debt restructurings: An empirical study of private reorganization of firms in default, *Journal of Financial Economics* 27(2): 315–353.
- Goodhart, C. A. E. (1999). Myths about the lender of last resort, *International Finance* 2(3): 339–360.
- Goodhart, C. & Schoenmaker, D. (2009). Fiscal burden sharing in cross-border banking crises, *International Journal of Central Banking* 5(1): 141–165.
- Gorton, G. & Huang, L. (2004). Liquidity, efficiency, and bank bailouts, *The American Economic Review* 94(3): 455–483.
- Gropp, R., Hakenes, H. & Schnabel, I. (2011). Competition, risk-shifting, and public bail-out policies, *The Review of Financial Studies* 24(6): 2084–2120.
- Hakenes, H. & Schnabel, I. (2010). Banks without parachutes: Competitive effects of government bail-out policies, *Journal of Financial Stability* 6(3): 156–168.
- Hannan, T. & Hanweck, G. (1988). Bank insolvency risk and the market for large certificates of deposit, *Journal of Money, Credit and Banking* 20(2): 203–211.
- Hart, O. D. & Jaffee, D. M. (1974). On the application of portfolio theory to depository financial intermediaries, *The Review of Economic Studies* 41(1): 129–147.
- Hart, O. & Zingales, L. (2011). A new capital regulation for large financial institutions, *American Law and Economics Review* 13(2): 453–490.
- Hauck, A. & Vollmer, U. (2013). Emergency liquidity provision to public banks: Rules versus discretion, *European Journal of Political Economy* 32: 193–204.
- Hauswald, R. & Marquez, R. (2006). Competition and strategic information acquisition in credit markets, *The Review of Financial Studies* 19(3): 967–1000.
- Heider, F., Hoerova, M. & Holthausen, C. (2010). Liquidity hoarding and interbank market spreads: The role of counterparty risk, *CEPR Discussion Paper No. 7762*. Centre for Economic Policy Research, London.
- Hellmann, T. F., Murdock, K. C. & Stiglitz, J. (2000). Liberalization, moral hazard in banking, and prudential regulation: Are capital requirements enough?, *The American Economic Review* 90(1): 147–165.

- Holmstrom, B. & Tirole, J. (1997). Financial intermediation, loanable funds, and the real sector, *The Quarterly Journal of Economics* **112**(3): 663–691.
- Honkapohja, S. (2009). The 1990's financial crises in Nordic countries, *Bank of Finland Research Discussion Paper No. 5/2009* . Helsinki.
- Honohan, P. & Klingebiel, D. (2003). The fiscal cost implications of an accommodating approach to banking crises, *Journal of Banking & Finance* **27**(8): 1539–1560.
- Hoshi, T. & Kashyap, A. (2000). The Japanese banking crisis: Where did it come from and how will it end?, *NBER Macroeconomics Annual 1999*, Cambridge, Massachusetts, pp. 129–201.
- Hoshi, T. & Kashyap, A. (2010). Will the US bank recapitalization succeed? Eight lessons from Japan, *Journal of Financial Economics* **97**(3): 398–417.
- Hotelling, H. (1929). Stability in competition, *The Economic Journal* **39**(153): 41–57.
- Huizinga, H., Bertay, A. C. & Demirgüç-Kunt, A. (2011). Is the financial safety net a barrier to cross-border banking?, *European Banking Center Discussion Paper No. 2011/037* . Tilburg.
- Ingves, S. & Lind, G. (1996). The management of the bank crisis - in retrospect, *Quarterly Review of Sveriges Riksbank* **1**: 5–18.
- Ingves, S., Lind, G., Shirakawa, M., Caruana, J. & Martínez, G. (2009). Lessons learned from previous banking crises: Sweden, Japan, Spain, and Mexico, *Group of Thirty, Occasional Paper No. 79* . Washington, D.C.
- Ioannidou, V., Ongena, S. & Peydro, J. (2009). Monetary policy, risk-taking and pricing: Evidence from a quasi-natural experiment, *European Banking Center Discussion Paper No. 2009/045* . Tilburg.
- James, C. (1987). Some evidence on the uniqueness of bank loans, *Journal of Financial Economics* **19**(2): 217–235.
- Jiménez, G., Ongena, S., Peydro, J. & Saurina Salas, J. (2009). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking?, *Banco de Espana Working Paper No. 0833* . Madrid.
- Jiménez, G., Lopez, J. A. & Saurina, J. (2007). How does competition impact bank risk-taking?, *Working Paper 2007/23* . Federal Reserve Bank of San Francisco.
- Jonung, L. (2009). The Swedish model of resolving the banking crisis of 1991-1993. Seven reasons why it was successful, *Economic Papers No. 360* . Brussels.

- Jonung, L., Kiander, J. & Vartia, P. (2008). The great financial crisis in Finland and Sweden. The dynamics of boom, bust and recovery, 1985-2000, *European Economy, Economic Papers No. 350* . Brussels.
- Kahn, C. M. & Santos, J. A. C. (2005). Allocating bank regulatory powers: Lender of last resort, deposit insurance and supervision, *European Economic Review* **49**(8): 2107–2136.
- Kanaya, A. & Woo, D. (2000). The Japanese banking crisis of the 1990s - Sources and lessons, *IMF Working Paper No. 00/7* . International Monetary Fund, Washington, D.C.
- Keeley, M. C. (1990). Deposit insurance, risk, and market power in banking, *The American Economic Review* **80**(5): 1183–1200.
- Kim, D. & Santomero, A. M. (1988). Risk in banking and capital regulation, *The Journal of Finance* **43**(5): 1219–1233.
- Knutsen, S. & Lie, E. (2002). Financial fragility, growth strategies and banking failures: The major Norwegian banks and the banking crisis, 1987-92, *Business History* **44**(2): 88–111.
- Laeven, L., Dell'Ariccia, G. & Marquez, R. (2010). Monetary policy, leverage, and bank risk-taking, *IMF Working Paper No. 10/276* . International Monetary Fund, Washington D.C.
- Laeven, L. & Valencia, F. (2008). Systemic banking crises: A new database, *IMF Working Paper No. 08/224* . International Monetary Fund, Washington, D.C.
- Laeven, L. & Valencia, F. (2010). Resolution of banking crises: The good, the bad, and the ugly, *IMF Working Paper No. 10/146* . International Monetary Fund, Washington, D.C.
- Laeven, L. & Valencia, F. (2012). Systemic banking crises database: An update, *IMF Working Paper No. 12/163* . International Monetary Fund, Washington, D.C.
- Landier, A. & Ueda, K. (2009). The economics of bank restructuring: Understanding the options, *IMF Staff Position Note No. 09/12* . International Monetary Fund, Washington, D.C.
- Leitner, Y. (2005). Financial networks: Contagion, commitment, and private sector bailouts, *The Journal of Finance* **60**(6): 2925–2953.
- Loranth, G. & Morrison, A. D. (2007). Deposit insurance, capital regulations, and financial contagion in multinational banks, *Journal of Business Finance & Accounting* **34**(5-6): 917–949.
- Mailath, G. & Mester, L. (1994). A positive analysis of bank closure, *Journal of Financial Intermediation* **3**(3): 272–299.

- Martinez-Miera, D. & Repullo, R. (2010). Does competition reduce the risk of bank failure?, *The Review of Financial Studies* **23**(10): 3638–3664.
- Matutes, C. & Vives, X. (1996). Competition for deposits, fragility and insurance, *Journal of Financial Intermediation* **5**(2): 184–216.
- Matutes, C. & Vives, X. (2000). Imperfect competition, risk taking and regulation in banking, *European Economic Review* **44**(1): 1–34.
- Mikkonen, K. (2006). *Regulation of multinational banks in the European Union*, PhD thesis, Ludwig-Maximilians-Universität München.
- Modigliani, F. & Miller, M. (1958). The cost of capital, corporation finance and the theory of investment, *The American Economic Review* **48**(3): 261–297.
- Morrison, A. D. & White, L. (2013). Reputational contagion and optimal regulatory forbearance, *Journal of Financial Economics* **110**(3): 642–658.
- Nagarajan, S. & Sealey, C. W. (1995). Forbearance, deposit insurance pricing and incentive compatible bank regulation, *Journal of Banking & Finance* **19**(6): 1109–1130.
- Nakaso, H. (2001). The financial crisis in Japan during the 1990s: How the Bank of Japan responded and the lessons learnt, *BIS Papers No. 6* . Bank for International Settlements, Basel.
- Niepmann, F. & Schmidt-Eisenlohr, T. (2013). Bank bailouts, international linkages and cooperation, *American Economic Journal: Economic Policy* **5**(4): 270–305.
- Niu, J. (2008). Bank competition, risk, and subordinated debt, *Journal of Financial Services Research* **33**(1): 37–56.
- Nyberg, P. & Vihriälä, V. (1994). The Finnish banking crisis and its handling, *Bank of Finland Discussion Papers No. 7* . Helsinki.
- Peek, J. & Rosengren, E. (2005). Unnatural selection: Perverse incentives and the misallocation of credit in Japan, *The American Economic Review* **95**(4): 1144–1166.
- Pennacchi, G. (2010). A structural model of contingent bank capital, *Working Paper No. 10/04* . Federal Reserve Bank of Cleveland.
- Perotti, E. C. & Suarez, J. (2002). Last bank standing: What do I gain if you fail?, *European Economic Review* **46**(9): 1599–1622.
- Perotti, E. & Suarez, J. (2009). Liquidity risk charges as a macroprudential tool, *CEPR Policy Insight No. 40* . Centre for Economic Policy Research, London.

- Petrovic, A. & Tutsch, R. (2009). National rescue measures in response to the current financial crisis, *ECB Legal Working Paper Series No. 8* . European Central Bank, Frankfurt am Main.
- Philippon, T. & Schnabl, P. (2013). Efficient recapitalization, *The Journal of Finance* **68**(1): 1–42.
- Reinhart, C. & Rogoff, K. (2008). Is the 2007 US sub-prime financial crisis so different? An international historical comparison, *The American Economic Review* **98**(2): 339–344.
- Repullo, R. (2000). Who should act as a lender of last resort? An incomplete contracts model, *Journal of Money, Credit and Banking* **32**(3): 580–605.
- Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking, *Journal of Financial Intermediation* **13**(2): 156–182.
- Repullo, R. (2005). Liquidity, risk-taking, and the lender of last resort, *International Journal of Central Banking* **1**: 47–80.
- Rochet, J. & Tirole, J. (1996). Interbank lending and systemic risk, *Journal of Money, Credit and Banking* **28**(4): 733–762.
- Salop, S. C. (1979). Monopolistic competition with outside goods, *The Bell Journal of Economics* **10**(1): 141–156.
- Sandal, K. (2004). The Nordic banking crises in the early 1990s - Resolution methods and fiscal costs, in T. G. Moe, J. A. Solheim & B. Vale (eds), *The Norwegian Banking Crisis*, Norges Bank, Oslo, pp. 77–115.
- Schich, S. & Kim, B.-H. (2010). Systemic financial crises: How to fund resolution, *OECD Journal: Financial Market Trends* **2010**(2): 71–104.
- Shin, H. (2010). Non-core liabilities tax as a tool for prudential regulation, *Policy Memo* .
- Sironi, A. (2003). Testing for market discipline in the European banking industry: Evidence from subordinated debt issues, *Journal of Money, Credit and Banking* **35**(3): 443–472.
- Stiglitz, J. E. & Weiss, A. (1981). Credit rationing in markets with imperfect information, *The American Economic Review* **71**(3): 393–410.
- Suarez, J. (1994). *Closure rules, market power and risk-taking in a dynamic model of bank behaviour*, LSE Financial Markets Group Discussion Paper No. 196.
- Takeda, M. & Turner, P. (1992). The liberalisation of Japan's financial markets: Some major themes, *BIS Papers No. 34* . Bank for International Settlements, Basel.

- Ueda, K. (1994). The financial system and its regulations, *in* T. Okazaki & M. Okuno-Fujiwara (eds), *The Japanese Economic System and Its Historical Origins*, Oxford.
- Vale, B. (2004). The Norwegian banking crisis, *in* T. G. Moe, J. A. Solheim & B. Vale (eds), *The Norwegian Banking Crisis*, Norges Bank, Oslo, pp. 1–21.
- Vaugirard, V. (2007). Informational contagion of bank runs in a third-generation crisis model, *Journal of International Money and Finance* **26**(3): 403–429.
- Vollmer, U. & Wiese, H. (2013). Minimum capital requirements, bank supervision and special resolution schemes. Consequences for bank risk-taking, *Journal of Financial Stability* **9**(4): 487–497.
- Vollmer, U. & Wiese, H. (2014). Explaining breakdowns in interbank lending: A bilateral bargaining model, *Finance Research Letters* (forthcoming) .
- Weder di Mauro, W. (2010). Taxing systemic risk: Proposal for a systemic risk levy and a systemic risk fund, *Presented at the Deutsche Bundesbank* .
- White, W. R. (2008). Past financial crises, the current financial turmoil, and the need for a new macrofinancial stability framework, *Journal of Financial Stability* **4**(4): 307–312.
- Wilse, H. (2004). Management of the banking crisis and state ownership of commercial banks, *in* T. G. Moe, J. A. Solheim & B. Vale (eds), *The Norwegian Banking Crisis*, Norges Bank, Oslo, pp. 179–207.
- Wilson, L. & Wu, Y. (2010). Common (stock) sense about risk-shifting and bank bailouts, *Financial Markets and Portfolio Management* **24**(1): 3–29.
- Yin, R. (2003). *Case study research: Design and methods*, Thousand Oaks, California.
- Yoshino, N. (1996). Effects of financial liberalization on banks, corporations, and monetary policy, *in* Y. Noguchi & K. Yamamura (eds), *U.S.-Japan Macroeconomic Relations*, Washington, pp. 194–221.

Wissenschaftlicher Werdegang

Ausbildung

- seit 04/2010 Promotionsstudium der Volkswirtschaftslehre, Universität Leipzig
- 09/2011–12/2011 Forschungsaufenthalt an der University of Illinois at Urbana-Champaign (USA)
- 10/2003–09/2009 Studium der Volkswirtschaftslehre, Universität Leipzig,
Diplomnote: 1,3, Betreuer der Diplomarbeit: Prof. Dr. Uwe Vollmer
- 09/2005–12/2005 Studium der Betriebswirtschaftslehre im Rahmen des Erasmus-Programms,
Ecole Supérieure du Commerce Extérieur (ESCE), Paris
- 06/2002 Abitur, Salvatorkolleg Bad Wurzach, Abiturnote: 1,5

Veröffentlichungen und Vorträge

- 2013 Zentralbankunabhängigkeit und Staatsschuldenkrise
in: T. Theurl (Hg.), Unabhängige staatliche Institutionen in der Demokratie, Berlin,
129-148, zusammen mit Uwe Vollmer
- 2011 Bankenrettung, „constructive ambiguity“ und moralisches Risiko
Jahrbuch für Wirtschaftswissenschaften, Vol. 62, 139-159,
zusammen mit Uwe Vollmer
- 09/2012 Vortrag: „Optimal public bank bailout and three funding alternatives:
can moral hazard be prevented?“
Jahrestagung des Vereins für Socialpolitik, Göttingen
- 05/2012 Vortrag: „Optimal public bank bailout and three funding alternatives:
can moral hazard be prevented?“
Workshop „Money, Banking and Financial Markets“, Düsseldorf
- 05/2012 Vortrag: „Who should rescue subsidiaries of multinational banks?“
Jahreskonferenz der Austrian Economic Association, Wien
- 05/2012 Vortrag: „Optimal public bank bailout and three funding alternatives:
can moral hazard be prevented?“
Jahreskonferenz der Austrian Economic Association, Wien

Selbständigkeitserklärung

Hiermit erkläre ich, die vorliegende Dissertation selbständig und ohne unzulässige fremde Hilfe, insbesondere ohne die Hilfe eines Promotionsberaters, angefertigt zu haben. Ich habe keine anderen als die angeführten Quellen und Hilfsmittel benutzt und sämtliche Textstellen, die wörtlich oder sinngemäß aus veröffentlichten oder unveröffentlichten Schriften entnommen wurden, und alle Angaben, die auf mündlichen Auskünften beruhen, als solche kenntlich gemacht. Ebenfalls sind alle von anderen Personen bereitgestellten Materialien oder erbrachten Dienstleistungen als solche gekennzeichnet.

Köln, den 30. Mai 2014

Bibliographische Beschreibung

Diemer, Michael

Bank Bailouts, Bank Levy, and Bank Risk-Taking

Universität Leipzig, Dissertation

204 S., 168 Lit., 17 Abb., 3 Tab.

Referat

This thesis is concerned with the relation between bank regulation and the risk-taking behaviour of banks. Two major instruments of regulatory intervention are considered: bank levy and bank bailouts. The major objective of this thesis is to provide an answer to the following questions: Do bank levies increase the risk-taking of banks in a competitive environment? When do bank bailouts decrease banks' risk-taking? Does the international coordination of bank bailouts affect the relation between bailouts and the risk-taking behaviour of banks? Who should rescue subsidiaries of multinational banks? How could an efficient bailout policy be designed and implemented?

The bank levy and cooperation between national regulators play an important role in the recently adopted Bank Recovery and Resolution Directive (BRRD). This directive is a cornerstone of bank regulation in Europe. Although the conversion of debt into equity (bail-in) in emergencies is the key component of the current regulation, bailouts, or at least the assistance to struggling banks, should not be excluded. As the ordinary resolution tools, for instance, bail-in, have not yet been tested in a real crisis, and due to the fact that it will take time to prepare global institutions for such a tool, it may be useful to have an adequately designed "tool of last resort" available, such as an adequate bailout policy, in order to avoid the disruption of critical economic functions.

We show that a bank levy may decrease banks' risk-taking behaviour. Bank bailouts can also decrease the risk-taking of banks. This depends on the regulator's ability to condition his bailout policy in accordance with the macroeconomic environment, which has an impact on the banks' probability of success, or on his ability to condition the bailout policy on the banks' systemic relevance. Coordination of bailouts through a multinational regulator can improve welfare. The desirability of internationally coordinated bailouts depends on the dimension of the crisis. If the crisis is severe, it may be more efficient to delegate bank bailouts to a multinational regulator. However, such a delegation is not always feasible. Therefore, a pre-defined burden sharing of bank bailouts is necessary in order to achieve an efficient resolution of banks in distress.